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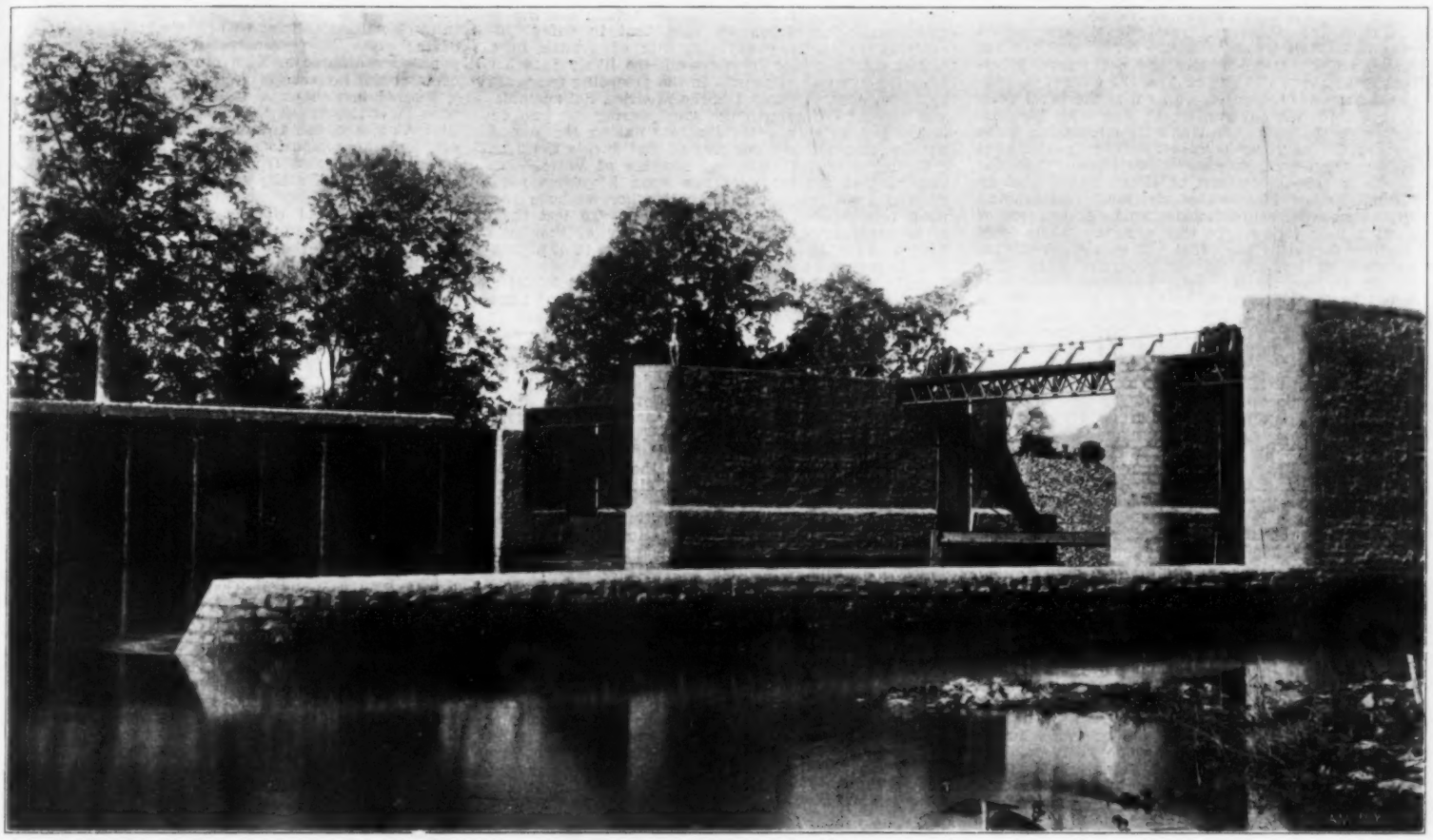
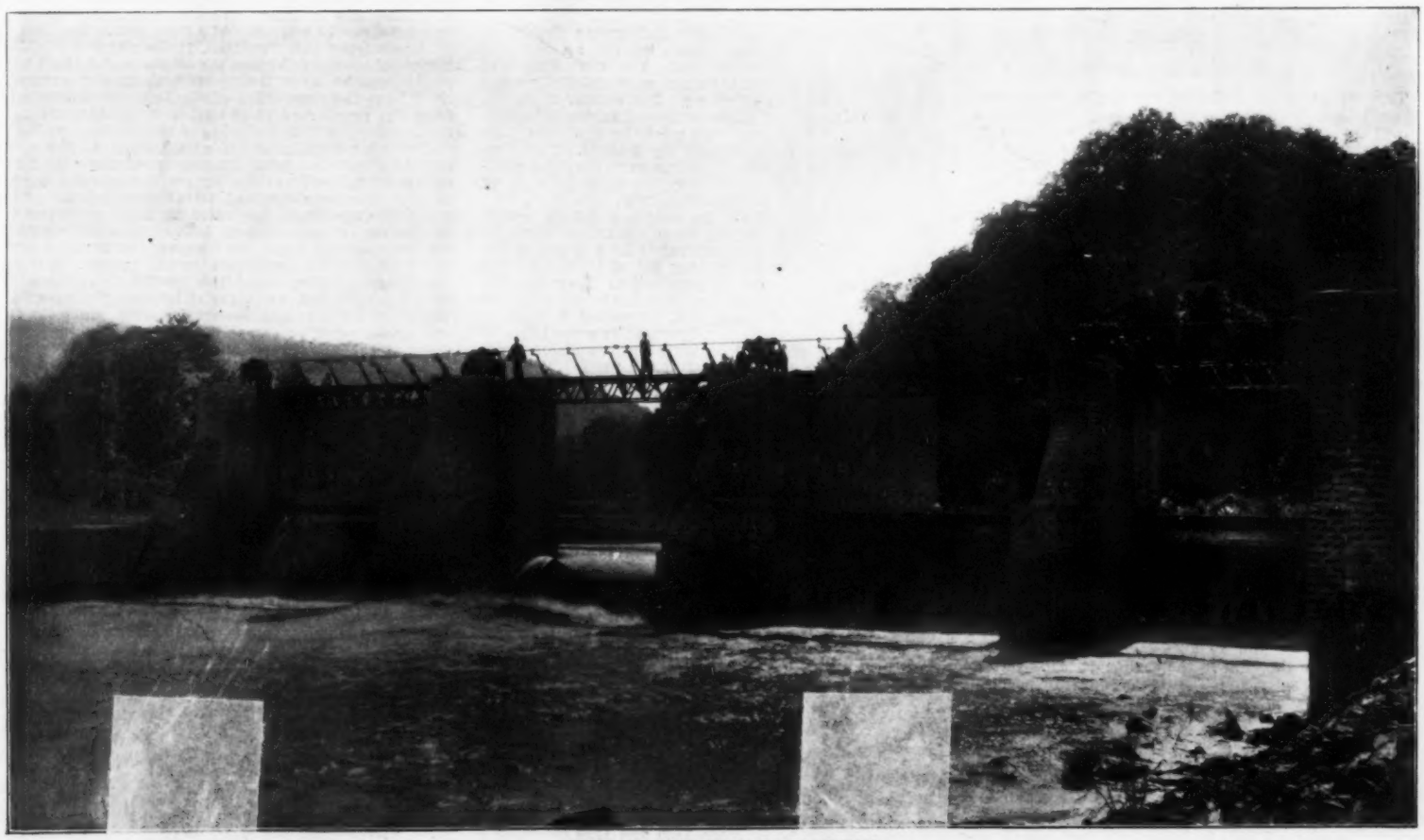


VIEW OF WEIR FROM UPSTREAM.



WEIR AS SEEN FROM DOWNSTREAM.

HEADWORKS OF THE MANDALAY CANAL, BUILT FOR IRRIGATION IN BURMA.

HEADWORKS OF THE NEW MANDALAY CANAL.

THE new Mandalay Canal, Burma, the headworks of which are shown in the accompanying photographs, has been located as close to the foot of the Shan Hills as possible, and is intended to irrigate the area between the Mandaya and the Myitnge rivers on the north and south, and the Shwetachaung Canal on the west. The Mandalay Canal itself forms the eastern boundary. The canal will supersede not only the abandoned Shwetachaung Canal, but also the existing Myaungnadaw Canal. The country through which it passes is mostly jungle, and the surveys naturally occupied a considerable time. It is expected that the jungles will be cleared and the country cultivated as the result of the completion of this enterprise.

The season at the headworks, between the time when the river went down sufficiently to admit of work being commenced and the time when floods might be expected to stop work, was a very short one. So heavy is the flow of water during freshets that it was found necessary to construct headworks which would pass over ten times the flood which was originally calculated as the minimum discharge. The irrigable area served by the canal will be about 89,000 acres; and the net revenue will be $165,000, and the net return is expected to be about 7.55 per cent on the outlay.

In carrying out irrigation works it is the usual practice of the British government to stop with the construction of the main canal and its tributaries, since these are the only works constructed at government expense; experience, however, has shown that the watercourses should at least be alined and graded by the canal authorities, so that the most commanding positions may be secured and a rapid development of irrigation may follow. To this end, the whole tract of country served by the canal has been covered with a network of levels. The watercourses, when they come to be constructed, will be owned and constructed by the cultivators, or by the government at the cost of the cultivators. Our illustrations of the headworks, which were taken by Mr. Johannes, of Mandalay, show the character of the work. The width of the weir across the river is 250 feet, and about the center of it, at the head of the weir sluices extends a long pier which projects far into the river and serves to catch the logs and driftwood which come down the river at times of flood and threaten the works at the weir and the head-regulator. The under-sluices of the weir are in four bays, each measuring 31 feet 9 inches in width. Each is closed by means of a girder let down by winches. Against the winches rest what are known as needle timbers, which are placed in contact with each other, side by side. The raising of the girder causes the timbers to fall outward and downward and allows of a flow, at very low water, into the lower part of the river beyond the canal head. The head-regulator of the canal contains twelve bays of 5½ feet width, with three gates in each bay. The depth of the canal varies from 30 to 35 feet, and the average width is 58 feet.

To compensate cultivators for the cost of constructing watercourses, on the plan mentioned above, and to hasten the development of irrigation, remissions of rates will be granted as follows: 1. For all leased State land and non-State land cultivated in the past, remission of half rates, for one year from the time water becomes available. 2. For all waste State land, remission of all rates for one year from the time water becomes available. It is expected that neither famine nor scarcity will ever affect the district; and the value of crops grown annually will, it is expected, be increased from 7 to 29 laks of rupees, the increase of 22 laks being shared in the proportions of two-thirds by the cultivator and one-third by the government.

METHODS OF ESTIMATING POPULATION.*

THE results of the Federal Census, giving the population of the several States and Territories, are accepted without challenge, both by Congress and by the country. But the accuracy of the figures for the population of a city is sometimes disputed or denied. Criticism of this character is made usually in good faith and is entitled to candid consideration. All such criticism of census figures assumes openly or tacitly either that a city's population can be determined in some other way with greater accuracy, or that an inconsistency between the census results and indications derived from other sources believed to be more accurate is warrant for rejecting the former. Various alternative ways of determining the population have been invoked, but for the purpose in hand the following are all that are important:

1. An estimate reached by assuming that the rate of growth between any two successive censuses is maintained during the following decade.
2. An estimate based upon the number of votes cast at an election.
3. An estimate based upon a school census.
4. An estimate based upon a directory canvass.

Estimates Reached by Assuming a Constant Rate of Growth.—The assumption that a city grew during the ten years from 1890 to 1900 at the same rate at which it grew during the ten years from 1880 to 1890 may be brought to the test of general American experience. The United States as a whole, excluding Alaska and the insular territories, increased between 1880 and 1890, 24.9 per cent, but between 1890 and 1900, 20.9 per cent, a decided reduction in rate of growth. Among the States and Territories, 19 grew at a higher rate and 29 at a lower rate in the last ten years than they did in the earlier decade. In only two, Massachusetts and Tennessee, was the per cent of increase between 1890 and 1900 within five-tenths of what it was between 1880 and 1890, and in half of the States and Territories it differed from that of ten years before by more than five. So far as indications derived from the rates of growth in the States and Territories can be applied to the cities, therefore, they show the chances to be even that the per cent of increase in a city during the ten years, 1890-1900, would differ from its per cent of increase during the preceding ten years by 5 or more, and the chances would be about 25 to 1 against its per cent of increase during the second decade being within five-tenths of what it was in the first.

But, as a rule, and other things being equal, the smaller the population the less the chance that its rate of growth from decade to decade will be the same. Hence, cities as a class would be expected to show a rate of growth less uniform than that of States.

In half of the 78 cities having a population of over 50,000 in 1900 the rate of growth between 1890 and 1900 differed by more than 18 per cent from the same city's rate of growth between 1880 and 1890; that is, in 39 of the 78 cities the increase between 1890 and 1900 was more than 18 per cent greater or more than 18 per cent less than it was during the preceding decade. If in the case of each city allowance were made for the effect of changes in city boundaries between 1880 and 1900, the record would be somewhat changed, but probably such corrections would not affect materially the inference to be drawn from it. As it stands it shows that American cities have a less constant rate of growth than the States and Territories. It shows, also, that in default of evidence to the contrary the rate of growth in a city during the last decade would be likely to differ from its own rate of growth in the preceding ten years by 18 per cent. In only 1 of the 78 cities, Philadelphia, was the rate of growth the same during the two decades, and in only 4 did the rate during the second decade come within 1 per cent of that during the first.

Estimates Based Upon the Number of Votes.—The method just analyzed depends upon illegitimate deduction from census figures; all other methods rest upon results from some other source. To test them it is needful to examine the accuracy of the basis figures and of the argument by which the total population is inferred therefrom.

A city's population is often estimated by multiplying the total vote at a recent election by some round number, such as 5. The abstract of vote cast is found in official documents, which may be assumed to be substantially accurate, though minor numerical errors frequently exist. How near to the truth is the assumption that the total population of a city is likely to be about five times the number of votes? It is evident that the ratio of votes to population must tend to vary as one or more of the following elements varies:

1. The proportion of males in the total population except in the cases of Denver and Salt Lake City, where women are entitled to vote.
2. The proportion of males of voting age, that is, 21 or over, in the total male population.
3. The proportion that the citizens make of the total males of voting age. By "citizens" is meant those who by birth or naturalization are citizens of the United States. The term for present purposes also includes a few State aliens who have indicated an intention to become naturalized, by taking out first papers, and who are allowed after a fixed time to register and vote.
4. The proportion of "citizens" as thus defined who satisfy the legal conditions of residence in the State, city, and voting district required as a prerequisite to voting.
5. The proportion of resident "citizens" who possess at the given election the educational or other qualifications, or who have paid the tax imposed in some States as a condition of voting.
6. The proportion of qualified voters who exercise their right to vote at the election in question by casting a ballot.
7. The proportion of ballots cast that appears in the largest total vote.

Of the foregoing conditions influencing the ratio of votes counted to total population not all are subject to statistical measurement. The census reports the number of each sex, the number of males of voting age, and the number of aliens. But neither from the census nor from any other source of information can the number of "citizens" who meet the residence, educational, or tax requirements, be derived. The election returns, as published, seldom give the total number of ballots counted, but only the total for each of a list of candidates and the scattering.

No information could be obtained which would serve, even approximately, as a statistical measure of the influence exercised separately by any one of the last conditions in the preceding list of those affecting the ratio of votes cast to population. They are important factors, but elude separate statistical measurement. The ratio of votes cast, November 6, 1900, to the total number of citizens, however, is some index of the joint effect exercised by these four conditions. To obtain the ratio, the vote cast at the presidential election of 1900 was analyzed with the aid of information furnished through the courtesy of the respective secretaries of state. To determine the total number of votes cast and counted in each city, the following figures were compared so far as they were obtainable:

1. The sum of the votes for the presidential electors receiving the largest number of votes in each party.
2. The sum of the votes for the several candidates for election to the national House of Representatives.
3. The sums of the votes for the several candidates for governor and other State offices.

The largest of these sums was assumed to be the best approximation to the total number of votes cast. Figures compiled in this way show that an estimate of the population made by multiplying the vote cast by any single ratio would be very wide of the mark in nearly all of the larger cities, and that this method of estimating a city's population is without foundation.

In the United States as a whole the divergence at each decade between the rate of increase of population and that of votes is not wide. In the earlier period the vote increased about 2 per cent faster than the population; in the later the relation of the two was reversed.

But in the five great groups of States a much greater diversity appears. Between 1880 and 1890 the population of the North Atlantic, South Atlantic, and Western divisions increased more rapidly than the vote, while in the North Central and South Central divisions the rates of increase in the vote were the greater. Between 1890 and 1900 the population of the North Atlantic, South Atlantic, and South Central groups increased much more rapidly than the vote; in the North Central and Western groups the increase in vote was the more rapid.

The real test of the hypothesis, however, is found neither in the figures for the United States as a whole, nor in those for the five divisions, but in those for the several States. In only four, namely, Connecticut and Oregon, from 1880 to 1890, and Michigan and Wisconsin from 1890 to 1900, were the two rates within 1 per cent of agreeing. This indicates that in American States and Territories under present conditions there is not one chance in twenty that the increase of population will keep even pace with that of votes cast. In half of the 94 instances examined the percentage of decennial increase of population differed from that of vote cast by more than 12. The variation between increase of votes and increase of population in the Southern and Western States is much greater than it is in the North Atlantic and North Central divisions, where most of the great cities of the country lie. But even in the North Atlantic and North Central States, in half of the cases the percentage of decennial increase of population differed by 8, or more, from the percentage of decennial increase in vote cast. Evidence previously offered has shown that the variations in such figures for cities are usually greater than they are for States. Hence, the argument applies to cities *a fortiori*, and the conclusion that in no way can a sound inference be drawn from the figures of vote cast to the population of a city seems established beyond reasonable doubt.

Estimates Based Upon a School Census.—Most of the States and Territories provide by statute for a periodical census of the population of school age. It is usually taken annually and the results published in State and municipal reports. For the purpose of such a census the school age as specified by statute is not the same in the several States and Territories, the lower limit ranging from 4 to 8 years and the upper from 14 to 20 years. The smallest number of years included is 10 and the highest 17. The most ordinary limits are 6 and 20, and 5 and 20, the former established by 11, the latter by 9 States. From the number of persons of school age as thus returned, an estimate of the population of a city is sometimes derived by multiplying the number of school children enumerated by the ratio which that class of persons is thought to bear to the total population. The accuracy of such an estimate depends upon the accuracy of the ratio and the accuracy of the school census. The ratio that naturally suggests itself as the best to employ in such a case, is that derived from the figures of the next preceding census for the city under examination.

The figures compiled on this basis show that the number of children between 5 and 20 years of age in 1900 for all the 78 cities collectively must be multiplied by 3.33 to get the entire population in 1900. But at the time these estimates were needed and made the census of 1890 was the last the figures for which were available, except for cities lying in States which had taken a State census between 1890 and 1900. The number of children between 5 and 20 years of age in 1890 for all the 78 cities collectively must be multiplied by 3.22 to get the entire population in 1890. To estimate the population in 1900 of any city on the list, its population of school age, which is supposed to be known, might be multiplied by the ratio which the number of persons of school age in 1890 bore to the total population in that year. In 68 of the 78 cities an estimate so reached would be too small, this being due to the decreasing proportion of children of school age in most of these cities. The average error of these 78 estimates is 5.7 per cent.

The evidence indicates that, if the number of children of school age is known, an estimate of a city's population can be made therefrom with greater accuracy than from the population of the last two censuses or from the number of votes cast at a presidential election.

The point remaining for examination is the accuracy of school censuses. By correspondence with State and municipal officers the figures for school censuses in 1900 have been obtained for 47 cities. But in only 4 are the age limits the same as those published by the Federal census, namely 5-20, and, in consequence, the information from these sources cannot be compared with much confidence in the results. But for the States and Territories the Twelfth Census reports both the ages 5-20, as in the cities, and the ages 5-17. There are 8 States and Territories from which, in one way or the other, comparable returns are obtained. But there are also 17 States and Territories in which the school age adopted by State authority differs by only 1 year from one or the other of those adopted by the Federal Government, 7 States and Territories in which it differs by 2, and 1 in which it differs by 3 years. As the Eleventh Census reported the population of each State and Territory classified by single years of age, and as the age composition of a State's population varies but little from decade to decade, it is possible to estimate with reasonable accuracy from the returns of the Twelfth Census the population of a State in 1900 within the age limits adopted by the State.

In the 8 instances in which the age limits of the two censuses are the same, and in which resort to estimates was unnecessary, the school census was deficient by amounts ranging between two-tenths of 1 per cent for Idaho and 24.0 per cent for New Mexico. Of the 25 cases in which recourse to estimates was necessary, the school census was apparently deficient in 18, including all States east of the Mississippi River except Illinois, Kentucky and Tennessee. It is probable that the State school censuses do not include Indian children of school age and that this partly accounts for the wide discrepancies in several Western States. But even in the Eastern States the results are so divergent as to cast doubt upon the State censuses of school children.

Estimates Based Upon a Directory Canvass.—An estimate of population is based more often perhaps on the number of names in the city directory than on any other figure. This is not due to the fact that the number of names in the directory is a more trustworthy index of population, but to the fact that many

* Abstract of a paper by Mr. Walter F. Willcox, chief statistician for methods and results of the Twelfth United States Census.

publishers of directories in each issue estimate the population. During the canvass they gain information that would be of much service in making an estimate, and are better prepared than others for the task. The directory estimate, based upon information gained annually and published by well-known firms, is given a wider circulation than is accorded to estimates made in other ways. Even where a directory publisher does not print an estimate in the directory, as is true in the majority of cases, he may give one out to the local newspapers, based upon the results of his canvass, or other persons may make estimates resting on the number of names in the directory.

These estimates are made by multiplying the number of names in the directory by a ratio assumed to represent the most probable number of persons in the total population to each name in the directory. It is more usual for directory publishers to print the number of names contained in the directory than it is for them to base thereon an estimate of the city's population.

The entries in a directory do not include the names of all adults, for those of married women seldom appear. Unmarried women living with their families and not engaged in any business are usually omitted. The age limit below which persons are excluded varies from 16 to 21. In a large city many men may be regarded as floating or transient population. Their addresses change so often that it is of little use to include them in a directory. Their social or business importance is so slight that the value of the directory to its public would be little heightened, if all their names appeared. The proportionate importance of this class, and the directory publisher's treatment of it, vary in the different cities and probably from time to time in the same city.

The directory publisher is not bound in any way to restrict his list to persons residing within the corporate limits of the municipality. A great many persons residing outside, but doing business in the city, are included in the city directories. Oftentimes residents of those suburbs which are an integral part of the city, viewed as a business center, are included even when they do not have a place of business within the corporate limits of the larger city.

The starting point of a directory must usually be the directory of the same city for the preceding year. Many of the residents have died or removed since the previous canvass. Many others have come to reside in the city since that time, or have begun business there. The names of the former must be expunged, those of the latter added. To get the necessary information and decide upon each case takes time and money. The efficiency with which this work is done varies in the different cities and in the same city at different periods.

For all these reasons the phrase "number of names" does not sharply define any class of the population and in consequence the ratio between the "number of names" and the population is not likely to be uniform. This is indicated by noting that, where directory publishers have estimated the total population during the last ten years by multiplying the number of names in the directory, the figure used as a multiplier varied from 2 to 5¼, and in most cases it was a simple number, namely, 2¼, 2½, 2¾, 3, 3¼, or 3½. Round numbers like these carry on their face a demonstration that they are the results of guessing rather than of accurate calculation. The evidence shows that the ratio between the number of names in a directory and the population is almost unknown, but varies with the age and sex composition of the population, and the conditions and rules of the directory canvass.

A tabulated statement of the directory figures in 14 out of 39 large cities shows that the ratios of "number of names" to population ranged from 1.75 to 3.21; and those used by the publishers from 2.08 to 3.50. Of the 14 estimates, but 4 are in error by less than 10 per cent; in 6 the error is from 10 to 20 per cent, and in 4 it is over 20 per cent. All of the estimates are too large. Only one instance has been found, either in 1900 or 1890, where a directory estimate was not in excess of the population as returned by the census.

If an estimate of population were based upon the "number of names" in 1900, as compared with that in 1890, the percentage of increase of population would probably be assumed to equal that of "number of names." The figures for 31 of the 78 cities show that the "number of names" has increased more rapidly than population. In but 7 of the instances is the percentage of increase in population greater than that in "number of names." This more rapid increase in the "number of names" witnesses probably to the greater care and thoroughness with which the work of directory publishing is done, to a tendency of the publishers to include a larger proportion of the doubtful classes, like unmarried women, or children just entering adult life, and also to a growing tendency among persons doing business in large cities to reside in the suburbs. For these reasons the directory is likely to give an exaggerated idea of the true resident population. On the whole, therefore, the evidence warrants the conclusion that this method of estimating population, like the other three, is not entitled to public acceptance or to any weight as a basis upon which to dispute the accuracy of a careful enumeration.

THE SCIENTIFIC STUDY OF ACCIDENTS.*

THE experiences of accident companies in dealing with the various businesses and occupations of the world have been reduced to a fairly scientific basis. It is now possible for these companies to foretell approximately the number and variety of accidents that men in certain businesses are exposed to, and fix their rate of insurance in such a way as to give a reasonable return upon the capital invested. The later idea of insurance of health is now in process of experimentation, but this phase of insurance has not been settled by any means, and it is possible that it will never be as satisfactorily arranged as the question of accidents, for an accident is a certain definite occurrence, like death itself, while sickness is a varying quality which admits of much malingering, if not actual deception.

* By J. Howe Adams, M.D., Philadelphia, Pa., in the Medical Fortnightly.

It is interesting to look over the manuals prepared for insurance agents by their companies. These books rarely get into the hands of the public, or even of the medical profession, and, therefore, the information that they contain is largely unknown to the medical profession.

It must be remembered that the classifications of occupations are not made up according to fancy or personal predilection, but are the result of the data of a long record of accidents.

In the first place, taking the prohibited list of businesses which are not insurable at all against accidents, we find naturally that manufacturers, users, or custodians of nitroglycerine, dynamite, or its compounds, cannot be insured against accidents; neither can powder-mill employés, cartridge or percussion-cap makers, or pyrotechnists. This is only natural, and the public, if called upon to name non-insurable businesses, would, undoubtedly, place these first of all upon the list. But there are other businesses which the accident companies regard as unfavorable, as making nitroglycerine or gunpowder. In the first place, soldiers in barracks or field service are regarded as equally ineligible, while the professional baseball player is viewed with as much disdain as the handler of dynamite. Submarine divers, aeronauts, circus riders and United States deputies supervising illicit distilleries, are all considered to be taking their lives in their hands in the pursuance of their daily work.

The next class of men whose work is considered so dangerous that they require special contracts in which they are limited to $250 in case of death, for which they must pay the comparatively enormous premium of $30 annually, are brakemen on freight trains or in yards, couplers, miners, and trimmers of electric light carbons.

After this special class comes the provision known technically as "special hazardous," in which the insured must pay $25 a year and be limited to $1,000 in case of death. Cowboys, cattle tenders, buzz-sawyers, hunters, lumbermen, sawmill employés, and employés of furniture, sash, blind and door manufacturers running machinery.

The next technical division is that of "extra hazardous," who are compelled to pay $20, and are limited generally to $1,500 for insurance in the average company. In this division come the majority of railroad employés, such as conductors on all kinds of trains, locomotive firemen and engineers, bridge builders and bridge carpenters. It also includes all sailors and such special businesses, as well as diggers, wood choppers, windmill builders and employés in iron and steel manufactures. Thus it will be seen that a sailor runs no more risk of accident than a train conductor.

The next class technically considered is the "hazardous" occupation, who must pay at the rate of $15 for $1,000, and are generally limited to $1,500 in case of death. This division contains many surprises, for the farmer and farm laborer is regarded as doing work as liable to accident as the firemen in the paid city departments. The common laborer comes in this class, as does the dairyman, the coal heaver, the ice man, the telegraphic or telephonic lineman, the quarryman, the cornice setter. There are also a number of the well-known trades which come under this division; these are the blacksmith, the butcher, the carpenter, the professional fisherman and sea pilot. The fact that the captain and mates on all classes of vessels have a better chance for life and limb is recognized by putting them in this class instead of the "extra hazardous." For some reason or other, on account of his ability, the train baggage-master is put in this class, recognizing him as a better risk than the conductor or the engineer.

We now come to a class of businesses which drop the ominous word "hazardous" and are called "extra medium." This does not avail them much, for they are still limited to $1,500, for which they must pay $12.50 annually. This includes bartenders, cable and electric road employés, celluloid workers, distillery employés, volunteer city firemen, employés in glass factories and hostlers.

We now begin to come down to the ordinary risks. The next class rejoices in the title of "medium;" they are limited to $2,000 insurance in case of death, for which they must pay at the rate of $10 a thousand annually. This includes a great many of the ordinary businesses, such as house-painters, boat-builders, bookbinders, bottlers, cabinet-makers, chocolate-makers, all kinds of ferrymen, makers of agricultural implements, makers of bicycles, attendants on the insane. It also includes such railroad employés as work around the track or station, such as car-painters, car-cleaners, air-brake inspectors, truckmen at the station, etc. It also includes the men who travel habitually on Pullman trains, such as the cooks in dining or hotel cars, porters and Pullman conductors. It is interesting to note that these trainmen are less exposed to accident than ordinary trainmen.

The next division of risks is that of "extraordinary," in which the amount is limited to $2,000, to cost at the rate of $8.50 a thousand. This division is rather an exclusive one, and contains such occupations as the superintendents of furniture manufactories, who, while not actually running the machinery, direct and make repairs.

The next type would probably be not over-pleased to hear themselves set down in insurance terms as "ordinary" risks. It includes such businesses as the bartender in a first-class hotel, bill-posters, bookbinder, boiler-inspector, superintendent of building, candle-maker, carver, gilder, civil engineer doing railroad work, private coachman, custom house inspector handling trunks, dyer, elevator man, etcher, fireman for stationary engine, gardener, glazier, goldbeater, harness-maker, hydraulic engineer, huckster, working jeweler, lithographer, mail service employé on railroads, paperhanger, professional cook, peddler, plasterer, porter, tailor, watchman and wood-carver.

Now comes the class of risks known as "extra preferred," who need only pay $6 a thousand, and are permitted generally to insure up to the amount of $5,000 in one company. This class of men are those who are generally superintendents, supervising contractors, supervising proprietors or manufacturers in the various lines of business. Insurance companies regard the men who supervise the work of their employés personally as not as good risks as if they confine themselves simply to office work.

The next two classes which are considered the cream of the accident business, are the "preferred" and the "select," who need pay only $5 and $4 respectively a thousand, the difference being that the select is allowed twice the maximum amount of the preferred for death as a rule. This includes men doing office work as a rule, such as architects, artists, lawyers, auctioneers, authors, barbers, bookkeepers, stock-brokers, all kinds of clerks, commission merchants, druggists, editors, grain-dealers, hotel-keepers, insurance agents, all kinds of proprietors or manufacturers who do office work only, all publishers, and such railway men as auditors, treasurers, superintendents, and the higher grade of officials who do not travel regularly; also ministers, typewriters.

I have purposely omitted all reference to physicians, leaving that to the last. Accident companies regard the physician as a better risk than the surgeon, and they regard the city physician better than his brother practitioner in the country. As the city physician is regarded as the best risk, he is put in the best class, the select; next comes the physician and surgeon with city practice only; he is placed in the preferred class, while the country physician and surgeon is placed down in the classification as "ordinary," which is the fourth from the top, for which he must pay twice as much as his city brother, and be limited to half the amount of indemnity in case of accident or death by accident. This is the cold-blooded view which the accident companies take of the dangers of the country doctor's life.

TEXTILE INDUSTRIES OF GERMANY.

AMONG the various products which form a component part of the foreign commerce of Germany, textiles hold an important place. The great industries of the manufacture and export of silk, cotton and woolen goods are kept alive by the importation of nearly all the necessary raw materials. The German manufacturers draw their supplies of raw cotton from Egypt, India, and the United States—the quantities imported from these countries in 1900 being respectively, 25,000, 26,000, and 256,000 tons. Small quantities of cotton find their way into Germany by way of England, Belgium, France, Holland, and Italy. The cotton of Egypt and India can be used only in the manufacture of certain textiles, while American cotton is used in the production of almost every grade and variety. In recent years India has increased her consumption of home cotton, and this has caused Germany to enlarge her use of Georgia cotton. Russia supplies one-third of her cotton consumption from Caucasia, Persia, and Turkey, so that very little cotton from those countries finds its way into German markets. Of flax, Germany produces only 10 per cent of the quantity needed to supply her mills. In 1900, over 31,000 tons of flax, valued at £1,000,000, were imported into the Empire, fully 90 per cent of which came from Russia. Much of this flax is reshipped by traders in Königsberg and Breslau to France, Bohemia, and Belgium. In former years, Germany produced a much greater quantity of flax than she does to-day. The introduction of cotton as a substitute in the linen industry, together with the development of railways in Russia, has had much to do with the decline of flax cultivation in Germany. Of hemp and pite, Germany produces but little. Vast quantities, however, are imported from Russia and Italy. In 1900, more than 45,000 tons of hemp, valued at £1,200,000, were imported. Tow and oakum were also imported from Russia in large quantities. Jute is gradually securing a prominent place in the manufacture of textiles. Germany imports annually about 70,000 tons. Sheep breeding in Germany is rapidly on the decline. Pasture lands adapted to grazing have been compelled to give way to the plow, and cheap ocean freights, which have enabled the wool-growers of Argentina, Australia, and Cape Colony, to underbid home products, have sealed the fate of this industry in Germany. Consul Harris, of Elbenstock, says, that in 1860 there were 28,000,000 head of sheep in all the different states, which to-day compose the German Empire. In 1873, this number was reduced to 25,000,000. The statistics for 1883 show 19,190,000, and for 1892 only 13,590,000. In the autumn of 1897 there were 10,000,000 sheep in Germany, or a decrease of 18,000,000 in forty years. This is the more significant when we consider that mutton forms a staple food product in the sustenance of any people, and especially so in Germany, where the inhabitants increase at the rate of 800,000 annually. At the present time Germany is only able to supply 25 per cent of the wool necessary for the textile industries. In 1900 nearly £10,000,000 worth of imported wool was consumed by the textile industries of the empire. As regards silk, many attempts have been made to cultivate silkworms in Germany. As far back as 1850 experiments were commenced, and they have often been repeated during the intervening years. The climate is not adapted to the culture of the mulberry, and thus far no equivalent has been discovered which will produce the same results. The total imports of raw materials necessary to sustain the various textile industries of Germany, amounted in 1900 to the value of £36,600,000; the import of piece goods, finished and otherwise, and all textiles, whether manufactured or in an unfinished condition, amounted to £8,000,000. The total exports of textiles from the German Empire in 1900 amounted to £48,600,000. In 1895, there were 995,257 persons employed in factories directly engaged in the manufacture of textiles. The tendency in Germany, with a few exceptions, is for large factories to rapidly absorb small ones. In 1897, the total production of all the textile factories in Germany amounted in value to £91,000,000. Of this sum, £42,600,000 worth was consumed at home. There are 150,000 persons employed in Germany in the manufacture of cotton goods. The countries which consume the greatest quantity of these goods, are England, Holland, Switzerland, Argentina, and Chili. German exports of cottons to South America have, however, declined in recent years. Nearly 100,000 persons are employed in the manufacture of hosiery in the German Empire. The annual output amounts to £7,100,000. The German hosiery

industry is situated principally in the Kingdom of Saxony. The German linen industries are located in Silesia, Lower Lausitz, Saxony, Westphalia, Wurtemburg, and Alsace. The statistics for 1897 placed the number of persons employed at about 80,000. There are more than 20,000 persons in Germany engaged in making cordage, thread, fishing nets, sails, sacks, etc. The annual output amounts to £800,000, one-fourth of which finds its way to Great Britain, Russia, and Denmark. On the whole, Germany's silk industry is on the decline. High duties, together with foreign competition, have placed German silk producers at a great disadvantage. England and the United States are the most important markets for German silk goods. There are about 120,000 persons engaged in spinning and weaving silks in the country. Of woolen goods, Germany exported in 1900 £10,600,000. The wool-weaving establishments of the empire give employment to 160,000 persons. In addition to the above-mentioned textile products, Germany produces carpets, rugs, clothing, corsets, hats, caps, artificial flowers, and feathers. In addition to the 993,257 persons employed in factories directly engaged in the manufacture of textiles as mentioned above, fully five times this number are indirectly engaged in these industries, says Consul Harris. The traders in cotton, flax, wool, and silk, with all their employés, the wives and children of the workmen, the interests connected with the outbound ships from Hamburg and Bremen, with their cargoes of woolen goods, hosiery, cotton and wool gloves, silk goods, trimmings, laces, lace curtains, etc., are all indirectly dependent upon the prosperity of these industries for an existence.—Journal of the Society of Arts.

BICYCLE BRAKES.

MANUFACTURERS have for many years been content to provide the bicycle with a brake that acts upon the tire and front wheel. It is certain that for those who make excursions only in regions where the country is not very hilly, this in most cases suffices; and there are even bicyclists who find it superfluous, and who would feel themselves disgraced if they did not remove from their machine an apparatus that they judge to be heavy and unsightly. They are wrong, however, since at a given moment, even upon a level, if the cyclist is running at some little speed, the use of a brake may prevent a serious accident. As for those who ride without a brake and venture into a hilly region, they are simply foolish persons with whom it is useless to reason, and whom we may merely prepare to take care of after they have become victims of their own imprudence.

Touring in mountainous countries has greatly developed during the last few years, and the inadequacy of the tire-brake has been fully recognized. In the descent of declivities, six miles or more in length, it cannot, in fact, be admitted that the rubber is capable of being submitted to a continuous friction without deterioration. For the last few years manufacturers have, therefore, been devising various brakes, some with drums analogous to the Lemoine brake employed upon omnibuses, and others with a shoe or block acting upon the felly. As it was quite difficult to form a decided opinion as to the value of one system or another, the Touring Club of France conceived the idea last August of organizing a competition in which various brakes were tried under severe enough conditions to allow those that withstood all the tests to be considered as efficient. We shall not dwell upon the details of this competition, a full report of which may be found in the Revue du Touring Club of last September, but shall simply give a brief description of some of the apparatus that withstood the ordeal.

The Bowden brake (Fig. 1, No. 3) is one of the oldest, and has been much employed in England for several years. It may be very easily mounted upon any bicycle.

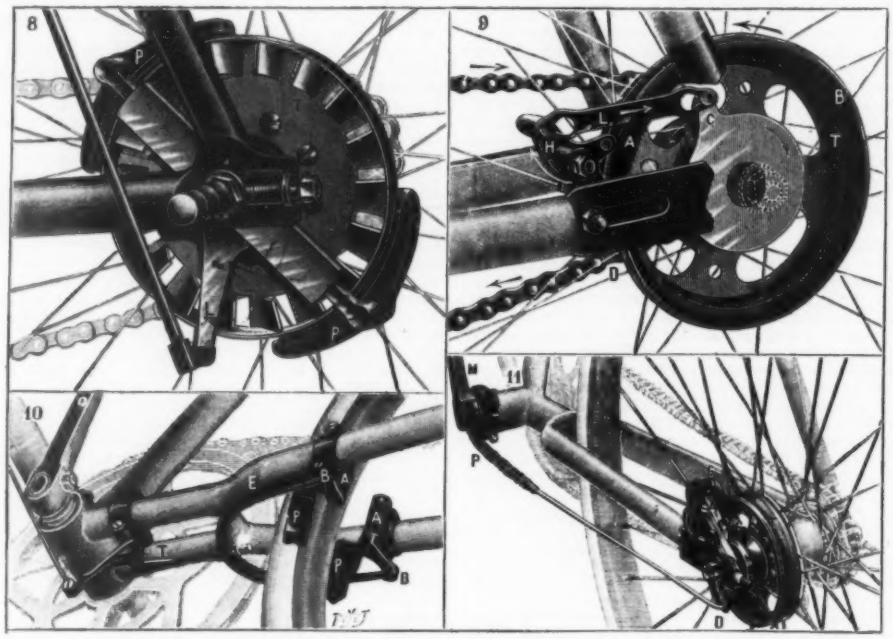


FIG. 3.—8. MONTET BRAKE. 9. HOCQUART-LEROUX BRAKE. 10. TERROT BRAKE. 11. RASSINIER BRAKE.

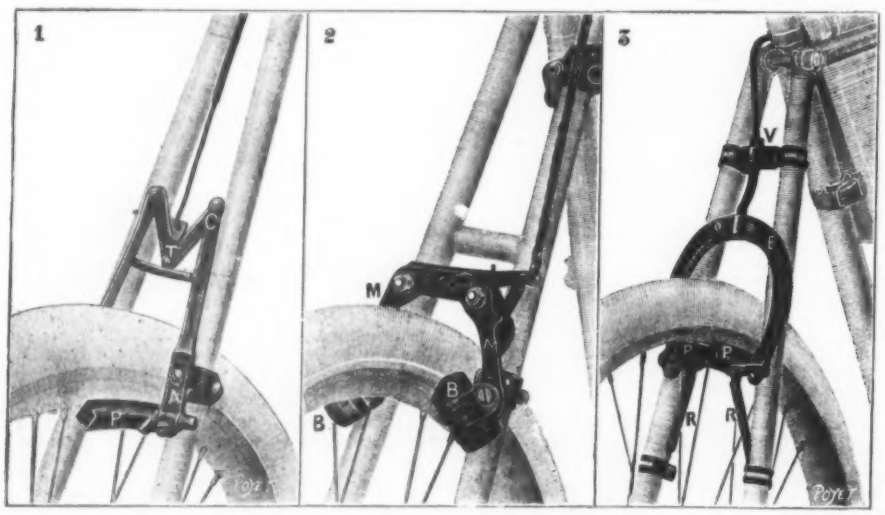


FIG. 1.—1. FLOQUART BRAKE. 2. DUNOIS (STOP) BRAKE. 3. BOWDEN BRAKE.

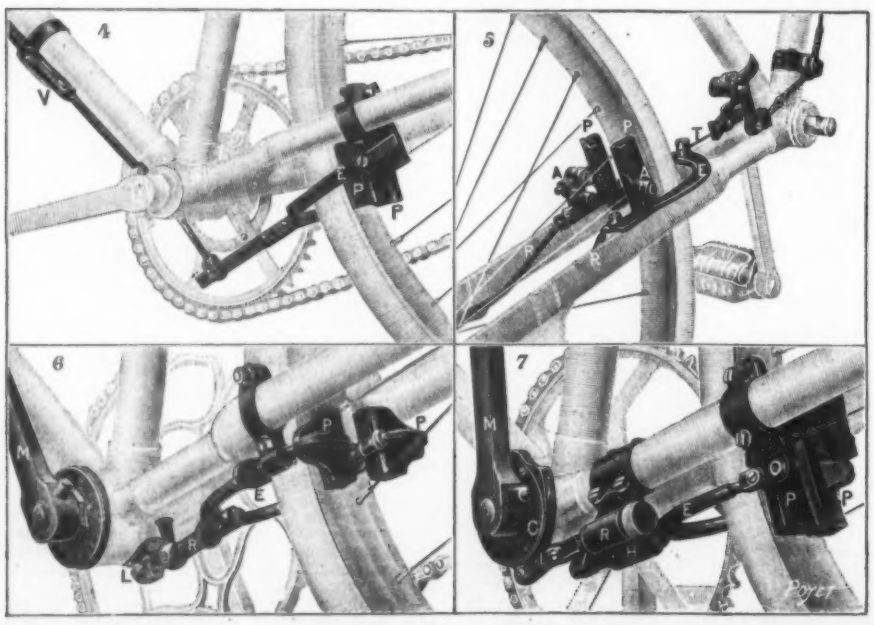


FIG. 2.—4. CARLONI BRAKE. 5. COSSET BRAKE. 6. PEUGEOT BRAKE. 7. B. S. A. BRAKE.

The blocks, *P*, are mounted at the extremity of a stirrup, *E*, which is placed against the rear fork of the frame. It is held in this position on the one hand by means of the springs, *R*, which tend to separate the blocks from the wheel, and, on the other, by a cross piece fixed between the uprights of the fork and carrying a nut, *V*, which permits of regulating the tension of the springs and consequently the distance of the blocks from the felly. A flexible wire that extends to the handle bar permits of drawing upon the upper part of the stirrup and of thus forcing the blocks to come into contact with the felly. It will be seen that, through the manner in which it is mounted, the entire brake remains absolutely free and displaces itself laterally, so that, if the wheel becomes sprung, it operates just the same, following the motions that the latter gives it to the right or left.

The Roudier brake is constructed upon the same principle and presents a similar aspect, and that is the reason that we do not illustrate it; but the control is effected through a rod instead of a flexible wire.

The Floquart brake (Fig. 1, No. 1) is entirely different, as regards action. The blocks grasp the felly at the sides like a pair of pincers. To effect this, they are mounted, at *P*, at the extremity of a lever, which is fulcrumed at *A*. The arm, *AC*, of the lever, which is longer than the arm, *AP*, is actuated by a jointed arm, *T*, to which is secured the controlling wire that runs to the handle bar. The arrangement of the block levers permits of a vigorous action of the blocks with a relatively feeble pull upon the controlling wire.

The Dunois brake (No. 2) is based upon somewhat the same principle as the preceding. The levers, *M*, are actuated by a double joint, *L*, connected with the controlling device. Upon the short arm are mounted the blocks, *B*, which are characteristic. They consist of leather cylinders working endways, that is to say, the friction against the felly is effected transversely with respect to the direction of the fibers.

The four models just described are placed at the upper part of the frame, while the following are mounted near the pedal bracket.

In the Terrot brake (Fig. 3, No. 10) the blocks, *P*, act upon the sides of the felly, and their operation is analogous to that of the jaws of a pair of nippers. They are mounted at the extremity of a piece, *PAB*, of which the pivot, *A*, is fixed to the upright of the fork and of which the extremity, *B*, is jointed to the extremity of the stirrup, *E*. The latter is provided with a rod, *T*, that connects it with the controlling rods.

The Cosset brake (Fig. 2, No. 5) is somewhat like the Bowden one as regards mounting, save that it is placed near the crank hanger and is controlled by levers that act at *T* upon the extremity of the stirrup, *E*, that carries the blocks, *P*. The latter are mounted to turn on axes, *AA*, and are kept away from the felly by springs, *RR*. These latter likewise keep the brake in place and allow it to have a certain lateral play that permits it to operate even upon a wheel that has become sprung.

The Carloni brake (No. 4) is controlled in a special manner from the handle bar. Upon turning one of the grips, we produce the torsion of a flexible wire which acts upon a screw, *V*, with quadruple threading and elongated pitch, which renders the displacement of the nut very rapid. This latter actuates a rod connected with a lever integrally formed with the stirrup, *E*. The extremities of the latter carry the blocks, *P*, and terminate in angle pieces that are jointed to collars fixed upon one of the branches of the fork. It will be seen from this that upon raising the stirrup by a pull upon its extremity, the blocks are applied to the felly.

The B. S. A. brake (No. 7) is actuated by foot through back pedaling. The blocks, *P*, are placed upon a stirrup, *E*, the extremities of which are jointed to collars fixed upon each of the branches of the fork.

The head of the stirrup is connected through the intermedium of springs inclosed in the cylinders, *R* and *H*, with a rod, *L*, which is attached to a disk, *C*, mounted upon the crank hanger after the manner of a free wheel, but in inverse direction. It remains immovable during forward pedaling, but is actuated during back pedaling. In this case the rod, *L*, follows the motion and exerts a traction upon the stirrup in applying the blocks against the felly. The object of the springs, *R* and *H*, is to cause the separation of the blocks when the foot is no longer acting, and to prevent too abrupt an action at the moment of back pedaling. It is certain that the action of the foot is always more abrupt and powerful than that of the hand, and the use of an opposing spring is therefore indispensable.

This arrangement exists likewise in the Peugeot brake (No. 6), in which we see the spring, *R*, interposed between the stirrup, *E*, carrying the block, *P*, and the rod, *L*, connected with the crank hanger. Here the entire mechanism is placed in the interior, but the action is the same. The rod, *L*, is connected with a disk that is set in motion only when the cyclist back pedals and causes the stirrup to apply the blocks against the felly.

We shall now examine some of the brakes that act upon a drum secured to the wheel, and generally to the spokes. The Montet brake (No. 8), which is controlled by hand, consists of two wide blocks, *P*, that press against a drum, *T*, provided with blades to prevent it from becoming heated. The axes that carry the blocks are at the extremity of rods that engage in guides, and their other extremity is connected with a metallic piece that the lever, *L*, displaces, in such a way as to apply the blocks to the drum in order to produce a more or less energetic friction.

The Hocquart brake (No. 9), constructed by M. Leroux, acts through back pedaling. A steel band, *B*, completely envelops the drum, *T*, and between it and the latter there is interposed a fatty composition called "camel hair" about two-fifths of an inch in thickness. One of the extremities of the steel band is fixed at *D* in an invariable manner, and the other is attached at *A* to a piece, *H*, connected with the lever, *L*. This latter is attached on the one hand to a lug, *C*, forming part of a disk mounted in such a way as to be actuated by back pedaling solely.

The Rassinier brake (No. 11) presents the peculiarity of being provided with rollers instead of blocks for acting upon the drum. This, at first sight, seems to be paradoxical for a brake. These rollers, *G*, are mounted at each extremity of a metallic piece that pivots through its center around an axis, *A*, carried by the extremity of a lever, *D*. When this lever is drawn upon, the crosspiece, *A*, tilts and the rollers bear against the drum, *T*, one at the exterior and the other in the interior. If the pull upon *D* is quite gentle, the rollers revolve upon their axis and the braking is slight, but if the pull is strong, the rollers gripe and no longer revolve, and then act by friction upon the drum, which they tend to arrest. The latter is controlled through the pedal by means of a rod connected with a disk which, as in the preceding models, is actuated only by back pedaling.

It has probably been remarked that we have not spoken of the composition of the brake-block. The reason is that this may vary to infinity, and that a certain apparatus that may to-day have leather or wooden blocks may to-morrow have blocks of another material.

The same is the case with the controlling apparatus. Almost all foot brakes might likewise be controlled by hand from the handle bar. As for the mode of transmission employed for control by hand, it is possible, in most cases, to employ the jointed rod or the flexible wire by traction or torsion. It is possible likewise, and this is very important for descents of long duration, to adapt to the controlling device an arrangement that shall permit of fixing the braking in a determinate position. For the above particulars and illustrations we are indebted to La Nature.

FIG. 1.

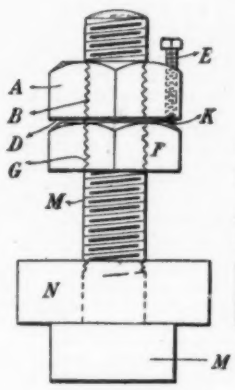
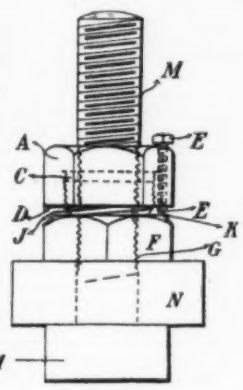


FIG. 2.



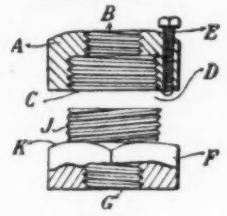


FIG. 3.

AN INGENIOUS LOCK NUT.

THERE are few automobilists who have not at some time or other had unpleasant experience with the failure of lock nuts, in spite of their name, to lock. We have, therefore, pleasure in drawing attention to the accompanying drawings of a novel design of lock nut, invented by Mr. A. G. Rosser, of Fremantle, W. Australia, and brought to our notice by Mr. A. Shields, of Messrs. George Callender & Co., 25 Victoria Street, S. W., in which coming loose appears to be practically impossible. The difficulty with ordinary lock nuts is that they tend to screw both in the same direction. The lock nuts illustrated in Figs. 1, 2, 3, do not suffer from this objection and can, as will be observed, be secured at any point on the bolt to which they are applied. The lock nut, *A*, is formed with the inner or bolt thread, *B*, in ordinary manner and with the threaded or screwed faucet of recess, as *C*, but of differential pitch to that of thread, *B*, while *D* refers to the lower face of the nut. Nut *A* is provided with the pinching or set screw, *E*. The holding nut, *F*, is also formed with its inner or bolt thread, *G*, and with the threaded projection, *J*, of a similar pitch to that of recess, *C*, but of a differential pitch to thread, *G*, while *K* denotes the upper face of the holding nut, *F*. The bolt, *M*, is formed with a thread of corresponding pitch to that of the screw thread, *B* and *C*, above referred to. *N* denotes the object which is being made secure. The manner of using this invention is mainly as follows: The two portions, as *A* and *F*, are first interscrewed so as to form one piece, and so as to be ready to be screwed freely on to the bolt, *M*, care being taken that the retention or check pin, *E*, does not project beyond the lower face, *D*, of the portion, *A*. The united portions, *A* and *F*, are now run on to the bolt and screwed tight home against the object, *N*, to be secured. To lock the holding nut, *F*, the lock nut, *A*, is unscrewed outward to the necessary extent, whereupon by reason of the differential threads, as *B* and *G* and *C* and *J* respectively, an antagonistic or lock action results, so causing both the parts, as *A* and *F*, to remain interscrewed but immovable on the bolt, *M*. To further secure the parts in their locked position the set screw, *E*, is screwed home so that it tightly impinges against the holding nut, *F*, so causing the nuts, as *A* and *F*, to be kept apart, as shown in Fig. 2. To unlock the nuts the pinch pin, *E*, is first released, and then the parts, *A* and *F*, are brought or screwed together so that their faces, *D* and *K*, touch, and are so made to resume the position shown in Fig. 1 so that they are free to run on the bolt.—The Automotor Journal.

PLATE-BENDING ROLLS.

WE illustrate a set of plate-bending rolls recently constructed by Messrs. Rushworth & Co., of Sowerby Bridge, for the Vulcan Locomotive Works, Newton-le-Willows. The rolls are all of forged steel, and will admit plates 11 feet wide between the standards. The top roller is 16 inches in diameter, and is prolonged to a third standard, as shown, where a screw is provided, by means of which the weight of the roller can be balanced, when it is desired to remove complete cylinders from the machine. This is done by taking away the upper portion of the standard on the right, which, it will be seen, is secured in its place by hinged bolts, in order to facilitate the work.

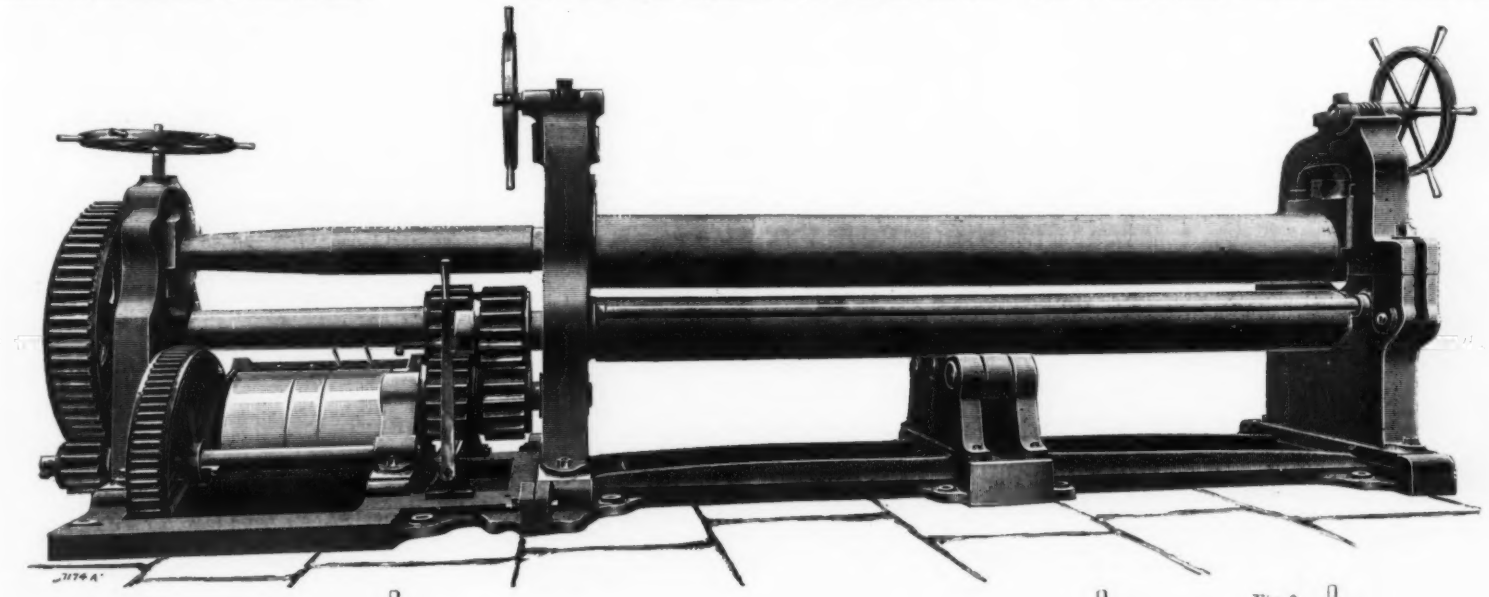


Fig. 2

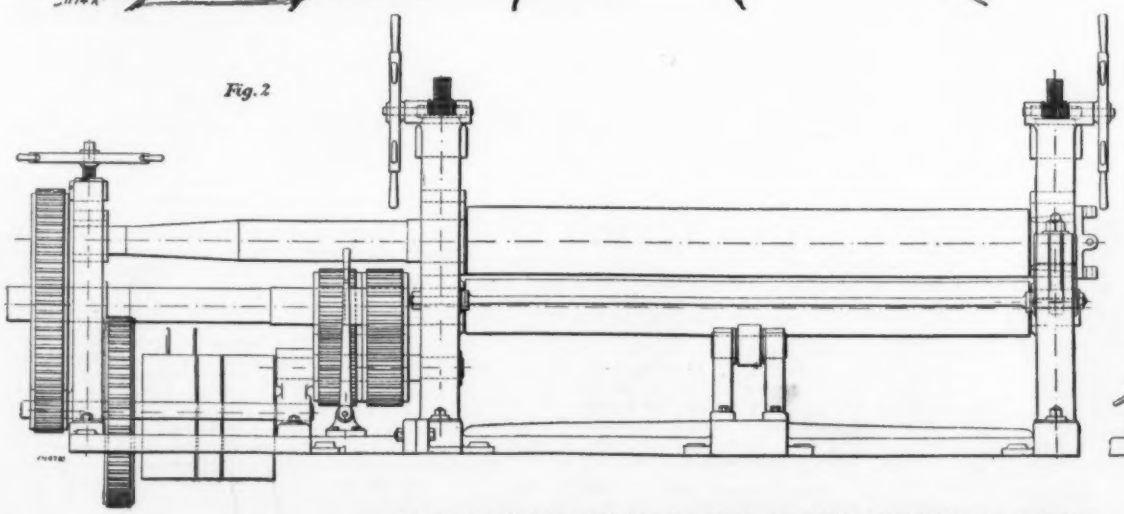


Fig. 3.

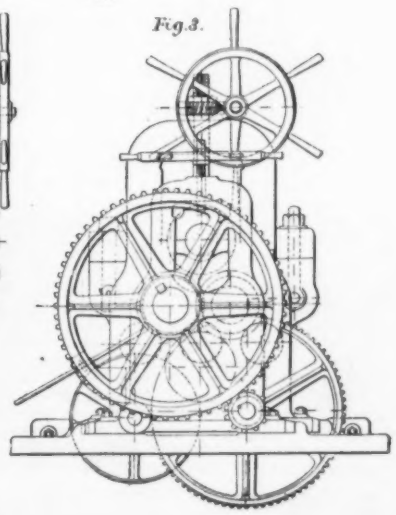


PLATE-BENDING ROLLS AT THE VULCAN LOCOMOTIVE WORKS.

The bottom rollers are 13 inches in diameter, and that connected to the driving wheel is, it will be seen, carried right through the third standard, an arrangement which facilitates the use of large spur gearing. The general appearance of the rolls is well shown in Fig. 1, while Figs. 2 and 3 represent a side and end view respectively. The reversing of the rolls is effected by means of "crossed" and open belting. The machine weighs complete about 22 tons.—Engineering.

THE SANITARY CONDITION OF STREET CARS IN NEW YORK.*

By GEORGE A. SOPER, Ph. D., of New York.

Two recent fatal disasters have served to focus a large amount of attention upon the question of public safety on railways in New York city. Referring to the New York Central tunnel collision and the explosion at the Park Avenue tunnel, Judge Cowing, in addressing the February Grand Jury, recently said:

"There are two cases which I expect will be placed before your body for its action and which have not only cost the loss of human lives but greatly shocked and disturbed the peace of this community. Public safety is an important consideration in a city of this size, and to prove this laws have been enacted for the protection of human life which, if they were enforced with celerity and zeal, should make disasters of this kind well-nigh impossible. There is a stage at which negligence of public safety becomes criminal. It is for you, gentlemen of the Grand Jury, to look into these matters with exceeding care and intelligence. If you find criminal neglect on the part of any person, do not hesitate an instant in bringing him before this bar, no matter who he may be, to be judged and punished."

From Judge Cowing's severe words, which fairly represent public sentiment, it might be inferred that liability to disastrous accident was the pending danger of city railway systems, but such in reality is not the case. Without intending to minimize this form of danger, which is great enough to be calculable and should certainly not be ignored, it must be stated that statistics show that great disasters cause a very small proportion of the total loss of human life on railroads.

The importance of railway dangers seems to be inversely proportional to the notice they receive. We hear a great deal about the loss of twenty lives in the smash-up which occurs on an average once in a decade, but we do not notice the loss of the three hundred lives which are snuffed out one by one by the trolleys and other railroads in New York city every year.

And there is another danger which is even less apt to be taken into account by the public. This is the danger of injury to health through the insanitary condition of our street cars. The importance of the subject is not to be denied. A vast amount of suffering and pecuniary loss is caused by preventable sickness in New York, and evidence is not wanting to show that the street cars are responsible for their full share in its causation.

Sanitary Condition of Street Cars.—Theoretically, the trolley car is a sanitary improvement over the public conveyance of a former day, but practically, as it is seen in New York, it is an invention of doubtful hygienic value. If we name in its favor greater size, better heating and lighting facilities and higher speed, we must also take into account the fact that it is not well adapted to carrying the great number of people who ride upon it. Under present conditions, greater size does not insure greater convenience; in the rush hours of night and morning it means greater discomfort. Cars with a seating capacity of from twenty to thirty people often carry from sixty to ninety passengers. How great overcrowding becomes is illustrated by the nightly spectacle of the throngs who seek transportation to their homes across the Brooklyn Bridge. At this point it is not uncommon for people seeking to board cars to be trampled upon; men and women have been killed here in their efforts to find a place upon the trolley cars.

The sanitary evils of overcrowding are not speculative. From the time of Sedgwick and Farr to the present day there has been a great stream of statistical and analytical evidence to prove that persons who breathe poor air and occupy crowded quarters furnish high death rates.

Physiological Effects of Poor Ventilation.—The physiological effects of poor ventilation are well known. Air vitiated by the lungs is low in oxygen, high in carbonic acid and high in organic matter. Want of a sufficiency of oxygen, combined with the presence of products of respiration in the air, causes a reduction of heart action, increase in the rate of respiration, tendency toward headache, loss of appetite, reduction of vitality, nervous exhaustion, and, in severe cases or in delicate organizations, nausea may be an immediate result of breathing foul air. Many who have traveled in overcrowded street cars are familiar with some of these effects and are aware of their injurious nature.

The power of resisting disease is lessened.

Poor ventilation causes the naturally vigorous condition of the tissues of the air-passages of the nose and throat, which normally have the power of rejecting or destroying dangerous bacteria, to become impaired and the entrance of the organisms which are the cause of bronchial and pulmonary disease is greatly favored.

The part played by human beings in gathering and giving off bacteria in the cars should not be forgotten. According to Thomson and Hewlett,† the number of bacteria inhaled by a human being under ordinary circumstances may reach many thousands during one hour's tranquil breathing. The air expelled is sterile, so long as there is no conversation; but Koeniger,‡ a pupil of C. Fraenkel, has shown that bacteria are freely given off in particles of moisture by persons in the act of speaking, whispering, sneezing or coughing.

Another effect of foul air is to offend the esthetic sense, which is a consideration by no means to be neglected in a sanitary question of this nature. The musty odor of close places is partly accounted for by Billings, Mitchell, and Bergey,§ who consider it to be due to volatile, fatty acids, associated with bodily excretions and the products of decomposition contained in the expired air of persons having decayed teeth, foul mouths or certain disorders of the digestive apparatus.

Proof of Insufficiency of Ventilation.—To those who have ridden in the street cars of New York during rush hours in winter, the fact that they are insufficiently ventilated needs no demonstration. The public, as though familiar with the dictum of De Chaumont† that the air of inclosed places should not be unpleasant to the sense of smell of persons coming from outside air, appreciates that the musty odor noticeable in poorly-ventilated street cars indicates that there are waste matters in the atmosphere which should have been promptly gotten rid of.

Now, an average adult takes into his lungs 396 cubic inches of air per minute and gives off the same amount of vitiated air, which must be greatly diluted before it is suitable for further respiration. The measure of this necessary dilution is very easily understood, for we know that, while fresh air contains about three parts of carbonic acid and air which has passed through the lungs 441 parts of carbonic acid per ten thousand volumes, the air of inclosed spaces becomes close when the carbonic acid exceeds about five parts per ten thousand. From these data it is found that something like 50 cubic feet of fresh air should be admitted to each car every minute per person.

It is clear that no such allowance of fresh air is supplied to passengers on any line of closed cars in Greater New York when they are running beyond their seating capacity. Such ventilation as occurs takes place irregularly by the opening and closing of the doors for the entrance or exit of passengers, or through primitive transoms and not by carefully-regulated ventilators. The writer has found the air of these cars to contain as much as 26.2 parts of carbonic acid gas, as determined by the Pittenkoffer method. Repeated counts of trolley cars in New York in cold weather have shown that about sixty per cent had all their transoms closed. The insufficient warming of street cars in winter accounts, in part, for the attempt made to keep them entirely shut up. Want of a sufficiency of warmth is a prevalent source of complaint and a danger to health, especially in the cars of Brooklyn.

Ventilation on the elevated roads is generally inferior to that on the surface lines, because of the greater size of the cars and smaller proportion of time during which the doors are opened and the people are stirring about.

Carbonic acid gas in the cars of the elevated road has been found by the writer to run as high as 31.2 parts.

The use of coal as a motive power, with the consequent gases, moisture and steam, adds considerably to the discomfort of passengers and makes the condition of the inclosed air especially unsatisfactory.

Bacterial Condition of the Air of Cars.—We have remarked how the street cars of New York are at times greatly overcrowded and have noted how overcrowding reduces the natural resistance of the body toward disease. It remains to show that specific sources of disease probably occur to a very considerable extent in the air of these overcrowded public conveyances.

That many species of bacteria exist in the street atmosphere of New York has been frequently demonstrated, by analysis, the quantitative work of Firth‡ and the isolation experiments of Dyar§ being fair examples of such proof. The fact that pathogenic germs exist in the street cars has been scientifically proved by Hance.‖

The elevated railroad cars are in some respects more insanitary than the surface cars. Examinations of the cocoa mats used on the floors of the cars of the elevated railroad have shown that fibers one and a half inches long may hold three or four million bacteria.

But there is no need of extending these data. Only straws of such evidence are necessary to show that the floors and air of street cars become polluted with dangerous bacteria.

The origin of many of the disease germs which occur in our street cars can be understood by anybody who has noticed the universal and disgusting habit of spitting. The Board of Health some time ago caused conspicuous notices to be posted, warning the public that spitting in the cars is a misdemeanor punishable with imprisonment and fine, but this order has become a dead letter. The steps and platforms of elevated railroad stations, with their disgusting accumulations of sand, and the cocoa mats of the elevated roads and the gratings on the floors of the surface cars are favorite places for those who indulge in this dangerous habit.

The findings of bacteriology leave no doubt as to the fate of a large part of the expectorated matter. It becomes dry and is pulverized under foot and is finally distributed through the air with dust. How far the spitting habit common in street cars is responsible for the eight thousand deaths from consumption of the lungs which occur in New York every year can safely be left to the reader's imagination.

Tuberculosis is not the only disease which is probably communicated in the street cars. From the facts at present known concerning the etiology of other infectious diseases, it can hardly be doubted that the infective poisons of scarlet fever, measles, influenza, diphtheria and pneumonia, not to say smallpox, are spread from person to person through the impure air and close personal contact which occur in the cars.

Conditions in Tunnels and Subways.—New York is soon to see a remarkable development of its railway-passenger traffic underground. It is expected that in two years a rapid transit service twenty-one miles long will be in operation under the streets of the city. The New York Central Railroad, which already operates several miles of subway, is to build extensive additions underground at and near its Forty-second Street terminal; the Pennsylvania and Long Island Railroads are to connect on Manhattan Island near Thirty-fourth Street by a road built under the city and under the North and East rivers, and other almost equally extensive projects for underground transit have been announced.

None of the plans for these subway roads, so far as made public, indicates that any special arrangements will be made for the permanent avoidance of the sanitary evils to which attention is here invited. In view of this fact, it may not be undesirable to inquire whether these dangers are likely to be especially prominent in the underground traffic and whether any additional risks are to be looked for in this form of city transportation.

From what is known to the writer at the present time, the greatest dangers to be apprehended on the underground roads are those of overcrowding, want of proper ventilation, and bacterial cleanliness.

Concerning the ventilation of cars, what has been said with respect to the surface lines and their needs will apply to the cars which will run in the subways, with this difference; the subway cars will be inclosures within an inclosure and consequently more difficult to ventilate.

In respect to ventilation outside of the cars, it is significant to note that the air of but few of the many tunnels so far built in various parts of the world is satisfactory. The Mont Cenis tunnel, the Hoosac tunnel, the underground roads of Paris, Liverpool, Glasgow and Boston, and the St. Louis and Baltimore tunnels are all imperfectly ventilated, if they are to be judged from a critical hygienic standpoint. The air in some of these tunnels is almost insufferable; men have been fairly suffocated in some of them, and a ride in the best is not infrequently attended by at least uncomfortable consequences.

It appears that there are no satisfactory methods of ventilating tunnels without great expense. Mechanical fans supplying or exhausting air and the use of blow holes, shafts or openings, through which air-currents caused by the passing trains are supposed to circulate, have been tried and found inadequate to insure that freedom from objectionable waste products which is the end aimed at in ventilation.

Failures in ventilating tunnels are usually due to a fancied necessity of operating them in the most economical manner possible. Practically the only reliable method of ventilating them requires the use of mechanical fans, and the operation of these involves a continuous and considerable expense. There have been those who have thought that the piston action of moving cars was sufficient to secure a sufficient interchange of air; that foul gases, being warmer than the rest of the atmosphere, would readily escape if vertical shafts were provided to carry them off; that the currents produced by the rapid passage of trains would cause the foul air to rush up and fresh air down, through blow-holes, and that large stations or occasional openings would afford suitable outlets for the escape of undesirable gases. Unfortunately experience has shown that too much reliance has been placed upon these cheap and easy methods and that, in the ventilation of large and important tunnels at least, they are not based upon a correct interpretation of physics or sanitation.

Aside from the use of fans, the most beneficial results have followed the opening up of large portions of the tunnel roof to the outside air. But this is not so much solving the problem of tunnel ventilation as it is escaping it. In proportion as a tunnel loses its covering it becomes an open cut.

It is interesting to note the ventilating arrangements of some well-known tunnels.

At Paris an attempt is made to ventilate the underground road of the Chemin de Fer de Secaux by exhausting the impure air with fans at the highest point of the line, fresh air being allowed to enter at the stations and through shafts. Blow-holes are located from 200 to 300 feet apart.

At Liverpool, the tunnel under the Mersey, 1.2 miles long, is provided with a ventilating equipment consisting of a 7-foot ventilating conduit alongside of the tunnel and provided with fans. Openings communicate between the tunnel and conduit at intervals. Foul air is forced out through this conduit and fresh enters at the ends of the tunnel. Analysis has shown that the carbonic acid in the air of the Mersey tunnel varies from 7.4 to 26.4 per 10,000 volumes.

The air in the subway of the Metropolitan Railway of London has long been a source of complaint. A government commission in 1897 found that the carbonic acid ran as high as 89.4 parts per 10,000. It was recommended that the tunnel be opened as far as practicable by removing portions of its roof.

It is interesting to note that a conclusion similar to that reached by these English investigators was recently arrived at by the Pennsylvania Railroad and the city of Philadelphia in connection with the work of depressing the tracks of the Pennsylvania road in that city. After devising an elaborate system of fans, conduits and stacks to secure a change of air every five minutes, this plan was rejected for a system of large street openings and a natural circulation of air.

Perhaps the conditions presented by the Boston subway resemble more closely those which may be expected on the rapid transit road in New York than could be found elsewhere. Fifty million people use the subway every year. There are about five miles of track. The entrances and large stations afford conditions favorable to the interchange of air. There is a ventilating equipment consisting of fans 7 to 8 feet in diameter, placed at intervals of from 500 to 1,500 feet. The air in the Boston subway was tested by Prof. Carmichael and found to contain from 6.53 to 9.45 parts of carbonic acid per 10,000 volumes of air. In a car with open ventilators and about sixty-five passengers the carbonic acid gas was 24.97 parts per 10,000. On the street at this time the carbonic acid was 4.5 to 5.9. It is true that the motive power used on most underground roads furnishes the chief cause of complaint and that the annoyance caused by the gases, steam, smoke and cinders given off by locomotives could be avoided by the use of electric traction. But have we any assurance that no coal will be used

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*Medical News.

†Trans. Royal Med. and Chir. Soc., Vol. xxviii., 1895.

‡Zeit. für Hg. V. 34.

*J. S. Billings, S. Weir Mitchell and D. H. Bergey, Smithsonian Reports, July, 1895, page 389.

†De Chaumont, Proceedings of the Royal Society of London, Vol. xxiii.

‡Studies from Dept. Path. College P. & S., N. Y., Vol. vii.

§Am. Annals N. Y. Academy of Sciences, Vol. viii., May, 1895.

‖N. Y. Med. Record, February 13, 1897.

on the underground railroads of New York? We have seen the tolerance of the public for this nuisance in times past. Locomotives burning coal have been running on the elevated roads and in New York Central tunnel through the heart of the city for many years and in the plans of the future subways the public has not been given assurance that the use of coal will be prohibited.

Disagreeable and unfavorable to health as the gases and solid matters given off by coal are known to be, the chief sanitary danger of cars under ground is the same as the chief danger of cars on the surface and cars overhead. The bacteria of disease are the objects against which the most unceasing warfare should be waged. In so far as the subways, with their openings for stations or ventilation, will be permitted to act as collecting-places for dust and disease germs, transit underground will be dangerous to health.

Conclusion.—The foregoing remarks indicate the nature and extent of what is possibly the greatest danger to which the people of New York are exposed in traveling by street cars. Under present circumstances, thousands of exhausted and fagged men and women seek the trolley and elevated roads every night and there fight for an hour or so for a place to stand while being transported from their business places to their homes. In the morning they repeat the experience. The foul atmosphere and inadequate warmth of the cars in winter predispose them to disease, and the unclean habits of a dangerous minority of the passengers sow bacterial poisons in the air. Insufficient heating and ventilation are prominent dangers also.

Is there any remedy for the sanitary evils of New York street cars? There are several. In the first place the power of the community to make laws for public safety should be utilized, and for this purpose it is needful that the necessity for such ordinances should be appreciated. Evidently, the call for decency and sanitary safety which has thus far been made by the Board of Health has not been heeded, and it is consequently incumbent upon every person who appreciates the importance of this subject to give it emphasis.

The principal objects toward which, as the writer believes, laws intended to improve the sanitary condition of street cars in New York should be directed are a reduction of overcrowding, the prevention of spitting, and the proper ventilation and warming of the cars. If overcrowding can be prevented, the problems of ventilation and warming can be properly solved, but not otherwise.

The remedies available for overcrowding lie in providing more cars to carry the people and in restricting the number of passengers carried per car. It is not possible to discuss this problem within present restrictive limits, but it may be said that a judicious application of both remedies is the solution to which the writer's study of this problem points.

The rapid transit road, now building, will relieve the congestion to some extent and most of the present lines can be made to handle many more cars than are now employed. If it were made unlawful for the companies to carry more passengers than they could accommodate with sanitary safety, there is little doubt that superior facilities for transporting the public in a decent and convenient manner would be forthcoming.

The prevention of spitting is the subject of greatest consequence in the sanitary improvement of street-cars. Until time develops a popular sentiment which will recognize expectoration to be a moral as well as a legal crime the most practical remedy for the nuisance seems to be to hold the transportation companies accountable for the condition of the cars. That the companies would be able to attend to this matter without undue hardship is evidenced by the fact that various rules for the safety of passengers are already enforced on the street cars of the city; for example, passengers are not allowed to ride on the steps of open cars in the summer and generally not on front platforms at any time.

As regards the sanitary aspects of the contemplated railroad subways not included in the rapid transit system, it would be premature to offer any criticism. The resources available for protecting public health under such conditions are sufficient to make these underground steam railroads inoffensive and sanitary. How far these resources of sanitation will be utilized depends largely upon how serious a view the public takes of its own safety.

TABLE SHOWING CARBONIC ACID IN THE AIR OF SOME TUNNELS AND STREET CARS. RESULTS STATED IN PARTS PER 10,000 VOLUMES.

Mont Cenis Tunnel	107.0
Mersey Tunnel	7.4 - 26.4
Severn Tunnel	4.5 - 11.4
Liverpool Overhead Electric Railway Tunnel	12.9
South London Electric Railway Tunnel	8.4 - 10.8
Metropolitan Railway Tunnel, max.	89.4
Boston Subway	6.53 - 9.45
Electric Car in Boston Subway	24.95
Steam Car on Elevated Railway, New York	5.8 - 31.2
Electric Surface Car, New York	6.1 - 28.2

PRIMITIVE CHRONOLOGY.

"THE History and Chronology of the Myth-Making Age," by Mr. J. F. Hewitt, late Commissioner of Chutia Nagpur, is the most important contribution to the science of folk-lore that has appeared since the republication of Mr. Frazer's "Golden Bough." It is the sequel to, and, in many respects, the development of, his work entitled "The Ruling Races of Prehistoric Times," wherein he surveyed mankind from China to Peru, and traced the adoption of the various seasons of the year to the astronomical observations of primitive peoples. Dr. Terrien de Lacouperie had already given to the world the result of his studies on the Western origin of early Chinese civilization, and Miss Simcox had very fully described the primitive civilization of Egypt, Babylonia and China. It is no disparagement to Mr. Hewitt's profound erudition to assert that, without the aid furnished by the Oxford series of "Sacred Books of the East" and similar translations, neither he nor any other scholar could have produced a volume like the present one, which, while compelling the admiration of all, yet cannot altogether escape the criticism to which the most brilliant triumphs of deductive reasoning are inevitably exposed. I shall, however, content myself, for the most part, with the modest task of describing the general features of a work which only a committee of specialists, with practically unlimited space at their disposal, are competent to discuss.

Up to the time of Niebuhr and the rise of the study of Comparative Philology and Mythology, the legends of the Prehistoric Age were generally thought to be based on the biographies of national leaders—men who had actually lived and died. These legends, although the deliberate fictions of later times, nevertheless embodied fragments of genuine old-world tradition. Mr. Hewitt has succeeded in proving beyond the possibility of further doubt that our most remote ancestors, in their wisdom, universally employed historic myths as their sole medium for recording history. Their official historiographers were only concerned with handing down to posterity the progress of the tribe or nation which employed them. For the living actors they substituted symbolically named persons whose names gave the key to the inner meaning of such stories, thus anticipating the heart-cry of the hero of "Locksley Hall:"

"And the individual withers, and the world is more and more."

The Age of Self-Advertisement was ushered in by the Gothe-Celtic invaders from the North, the Arya, or "noble people," whose language was Sanskrit, and whose chroniclers were the family or tribal bards who celebrated the doughty deeds of their foremost warriors. Thenceforward the rules for interpreting the ancient myths, which had, for countless generations, been carefully taught to the youth of both sexes, fell into oblivion.

Prior to this, to quote Mr. Hewitt:

"Oral instruction was given in the form of stories which had to be learnt by heart from the dictation of the teacher. . . . But these stories were not dry statements of facts or metaphysical precepts like those in Brahmanic and Buddhistic literature, but tales which interested their young hearers, in which first nature myths and subsequently national history were depicted as the work of the authors of natural phenomena. An excellent example of these stories is that of Nala and Damayanti in the Mahabharata, which contained . . . the first plan of the plot of this great national history in verse combined with meteorological teaching. In these stories . . . the names of the actors are never names of individuals but symbolic signs showing clearly in all cases in which the story can be traced to its original source, the meaning of the tale."

What, then, is the Myth-Making Age, the history and chronology of which we are about to consider? It is the whole period from the earliest dawn of civilization down to the time when the sun entered Taurus at the Vernal Equinox between 4000 and 5000 B. C., according to certain fairly good contemporaneous Egyptian and Chinese records. Mr. Hewitt treats this event as occurring about 4200 B. C., but some writers place it tentatively at 4700 B. C.:

"It was then that it ceased to be a universally observed national custom to record history in the form of historic myths, and that national history began to pass out of the mythic stage into that of annalistic chronicles recording the events of the reigns of kings and the deeds of individual heroes, statesmen and law-givers. These latter histories were, when formed into national historical records, always prefaced by a summary of the previous mythic narratives which were more often than not manipulated and distorted from their original form by the authors of what may be called the Individualist School of History."

I now pass to the consideration of the sources from which the histories of the Myth-Making Age can be pieced together. First, there are the verbal histories prepared by the official historians of each governing State; second, the pictorial histories told in the engraved bas-reliefs and picture papyri of Egypt, and of the Turano-Hittite trading races who drew the rock pictures of Iasilikaia in Cilicia and many similar pictographs, together with pictorial history told in symbols; third, the histories handed down in the forms of national ritual.

Of all sciences the oldest is incontestably astronomy. We cannot picture to ourselves a time when man gazed unmoved on the starry host, and his soul soared not beyond the blazing ramparts of the world:

"The principal lessons taught in the oral instruction of the village children were those which told them, from a farmer's point of view, of the course of the year and the sequence of the seasons. These are the themes of almost all the earliest relics of ancient thought which have come down to us in folk-tales, such as the stories of the two or three brothers or sisters, in which the youngest, the winter child, was successful, and of the year tasks done by the final conqueror. Most of these refer to the year of three seasons, but the earlier year of two seasons appears also among them. Also the history of the year and the changes in its reckoning are the themes forming the plot of all the ancient historical epics of India, Persia and Greece, in which the heroes were, in the original forms of the story, astronomical abstractions indicating the successive methods of year measurement, which in primitive history accompanied each change in the ruling race. But the primitive year legend has been in Greece transmogrified by the later poets, who had forgotten the old mythology. In Persia and India the primitive form is much more easily recognized."

Mr. Hewitt divides the Myth-Making Age into three periods, each period being subdivided. These are, in the main, as follows: 1. The Age of Pole-Star worship; (*a*) the year of two seasons and five-day weeks measured by the movements of the Pleiades and the solstitial sun; (*b*) the year of three seasons and five-day weeks ruled by Orion the deer-sun god; (*c*) the year of three seasons of six-day weeks ruled by the eel-god, the parent fish of the sons of the rivers. 2. The Age of Lunar-Solar worship; (*a*) the epoch of the three years' cycle and of the nine days' week; (*b*) the year of the hor.'s head of eleven months and eleven-day weeks. 3. Solar Worship (*a*) the fifteen-months' year of the sun-god of the eight-rayed star and the eight-day week; (*b*) the years of seven-day weeks and seventeen and thirteen months; (*c*) the years of eighteen and twelve months, and of five and ten-day weeks.

As each of these time measurements is the result of an elaborate process of deductive reasoning, which constitutes, as it were, a chain composed of links of varying size, it is manifestly impossible, within the limits of a short paper, to touch, even superficially, on them all. Such being the case, I will confine myself to an analysis of Mr. Hewitt's description of the Age of Pole-Star worship.

Each associated community was anxious to ascertain the order and approximate dates of the seasons, so as to begin each season with propitiatory ceremonies, whence it followed that the supreme national god of the organizers of society was the maker and measurer of time, who imparted a knowledge of its sequence to the animals of the chase, and gave life to the trees and plants, and prepared the earth to receive the seeds sown, and also to bring them to maturity. "He was the being by whose orders the sun, moon and stars rose and set, and went daily round the Pole." The Dravidian villagers sought in the kindly stars of night a sign to mark the beginning of the equatorial spring, and found it in the Pleiades, which began to set, as they perceived, after the sun on November 1. Thus the primæval year consisted of two seasons, viz., the productive and unproductive, from November to the end of April, and from May to the end of October, on which latter date most Indian merchants close their annual accounts. The primitive week consisted of five days, or rather five nights, reckoned from 6 P. M. There is cumulative evidence to prove that the Pole Star was watched in India from 21,000 B. C., when it was first a start in Kepheus, a Greek form of the Indian Kapi, the Greek κῆτος the Latin cebus, all meaning the ape. Now, the Egyptian Pole-Star god is the ape-god Seb or Hapi, who sits on the world's tree with his thigh, i. e., the Great Bear, pointing to the Pole Star his head, and thence he turns the stars round the Pole.*

As the Dravidians advanced up the Euphrates Valley they lost sight of their parent-star, Canopus, and Orion, the deer-sun god, was substituted in its stead. Orion *hunted* the Pleiades and their attendant stars round the Pole—a notion which arose among the hunting races of the North, the cave-men of the Palæolithic Age, who had domesticated the reindeer, the shedding of whose horse in autumn heralded the approach of winter, as their regrowth in spring heralded the approach of summer. He is identified with the Celtic sun-god Cernunnos, whose forehead is adorned with deer's horns, and who was originally the English Herne the Hunter. In the Indian story Prajapati, Orion (in deer form) pursued Rohini (the star Aldebaran, Queen of the Pleiades) in the form of a roe, and was ultimately shot with the "three-headed" arrow of Rudna (the three stars in Orion's belt). The feather indicates the spring, the shaft the summer, and the barb the winter—the year of three seasons and five-day weeks.

The close of the Palæolithic Age saw mixed tribes of farmers, hunters and shepherds congregated together in Asia Minor. These tribes had a double ancestry. "As the sons of the South, they were the sons of the cloud-bird Khu and the mother-tree, and as sons of the North, the children of the deer-sun god and of the mother-mountain, fertilized by the rain-mist enshrouding its top, and descending to its base in the parent rivers which water the earth with the seed of life." The southern tribes inherited the tradition of a fish mother of life dwelling in the abyss of the Southern Ocean. She became to the Finns the eel-goddess Il-ja, the Icelandic áll, the German Aal. Mr. Hewitt takes the view that these Finns introduced the god-name Il or El of the Semitic peoples:

"Thus the eel-god is the plowing-god, the worker (ουργος) of the earth (γῆ), the rain-god who marks his furrows in the earth by the trail of the tiny rain-streams he plows on the surface, which grow into the river-parents of life. He is thus the god of the channel (*nahr*), the Gond Nagur, the plow-god and the god of the plow constellation of the Great Bear."

The Age of Pole-Star worship closes with a year of three seasons of six-day weeks ruled by the eel-god, the parent-fish of the sons of the rivers.

The fruit of Pope Gregory I.'s wise advice given to his missionaries not to alter the festivals of newly converted peoples beyond bringing them, as far as possible, into conformity with the new doctrines, may be seen in the annual procession of the Ceri at Gubbio on May 15, and the solemn dance at Echternach on Whit Monday. Mr. Hewitt goes very fully into the inner meaning and historical significance of these ceremonies which, in remote ages, were connected with the worship of the sun. Most people will learn with surprise that the well-known doggerel "The House That Jack Built," of which Basque and Talmudic versions exist, was a primæval nursery lesson dating from the age of the cycle-year ruled by the Pole-Star goat. But these and many other curious problems find their solution in the stimulative pages of Mr. Hewitt's latest work.—W. F. Harvey, in The Westminster Review. The Leonard Scott Publishing Company, New York city.

Waterproofing for Boots.—A very good waterproofing application for boots and shoes is the following:

Linseed oil	30 parts
Mutton suet	15 parts
Yellow wax	15 parts
Rosin	1 to 3 parts

Melt together over a gentle fire, and after the mixture is homogenous let come to a boil, being careful not to let boil over. Stand aside and let cool. When cooled down to about 140 deg. F. apply to the shoe or boot, using a hairbrush, and going entirely over the article. On the first application give two coats, being careful to get the preparation well into the seams around the soles, etc. For subsequent applications one coat (also applied quite hot) will be sufficient.—National Druggist.

* The slaying of Osiris, the year-god, by Set and 72 assistants shows that the reckoning of 73 weeks, forming a year cycle of 365 days, was adopted at a very early period.

THE NEW GERMAN CRUISER "PRINZ HEINRICH."

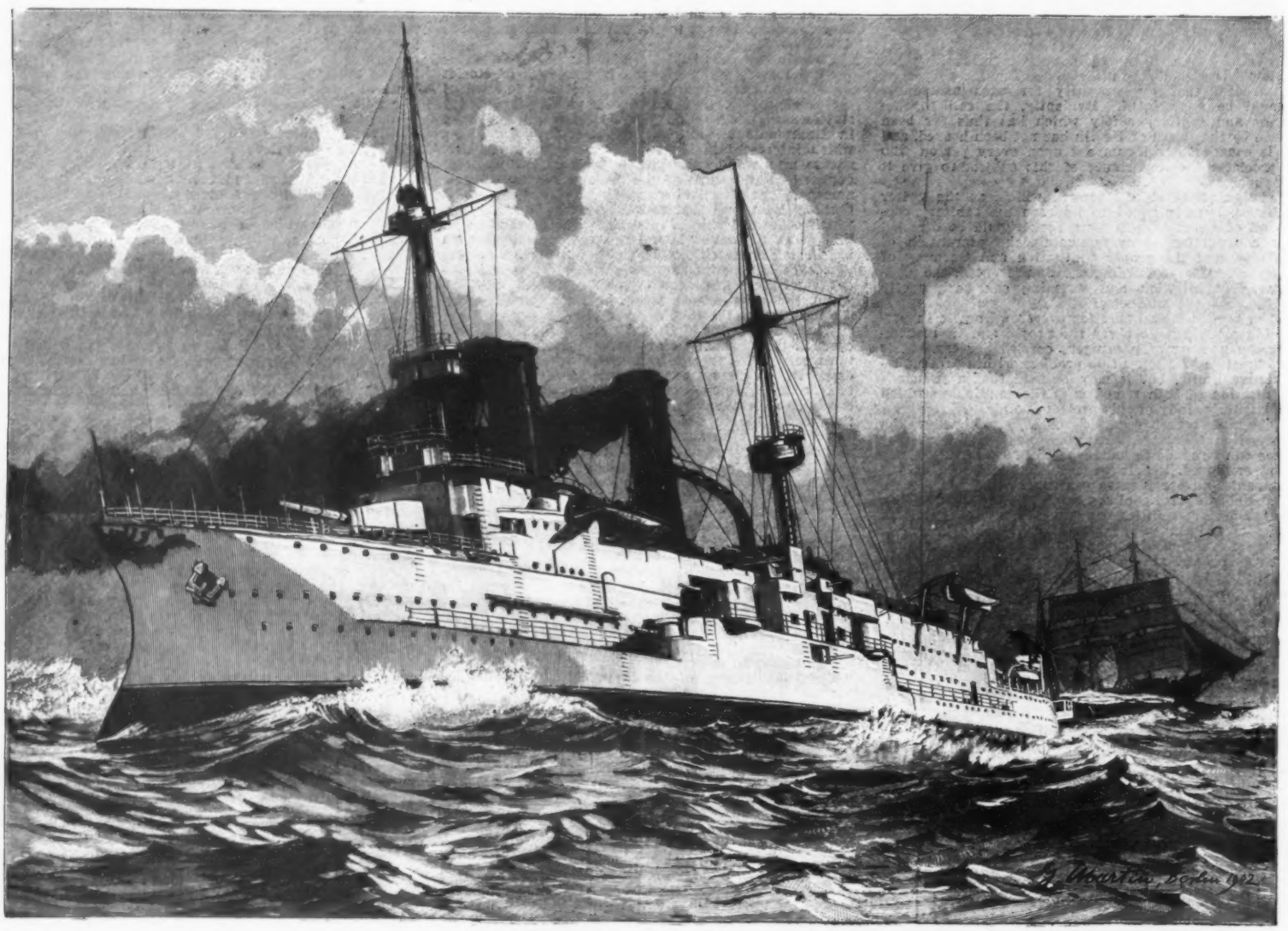
THE new German cruiser "Prinz Heinrich" is now so far completed that the trial trips can be begun shortly. The result of the trial trips is awaited with great interest, since this vessel represents an entirely new type not represented in the German navy, and as regards size and strength of armament and armor protection stands between the gigantic armored cruiser "Fuerst Bismarck" and the vessels of the "Freya" class.

The construction of the "Prinz Heinrich" was commenced in December, 1898, at the imperial shipyards in Kiel, and has therefore required a little over three years. The vessel is 393.6 feet long and 64.3 feet beam and, fully equipped, has a draught of 24 feet and a displacement of 8,930 tons. Like all the other new large ships of the German navy, she has three screws driven by the like number of separately mounted four-cylinder engines with triple expansion. The maximum speed is calculated at 20.5 knots. The armament consists of two 24-centimeter (9½-inch), ten 15-centimeter (6-inch) and ten 8.8-centimeter (3½-inch) quick-fire guns, as well as ten 3.7-centimeter (1½-inch) machine guns. The two heavy guns are mounted in two revolving turrets forward and aft and have a free arc of fire of 270 degrees each. Of the ten guns of the secondary battery (6-inch caliber) six are placed in the casemate, three on each side, in such a manner that the two forward ones can also fire dead ahead and the two after ones dead astern.

The slightly arched protective deck, which in the case of the beltless vessels, "Freya," etc., has a thickness of 4 inches, possesses with the "Prinz Heinrich" only a thickness of 2 inches, even tapering down to 1.5 inches.

The coal bunker capacity is very large—950 tons—as is consequently also the radius of action of the vessel, which naturally considerably increases her usefulness. The complement consists of 15 naval officers, 4 marine engineers, 2 doctors, 12 ensigns, 1 paymaster, 24 deck officers and 446 sub-officers and crew, hence altogether of 504. All the rooms of the vessel are provided with electric light, and the living rooms with steam heat besides.

Despite her gigantic dimensions, the "Prinz Heinrich" makes a very pleasing impression, which is especially due to her slender form and fine lines. The appearance of the vessel is much enhanced by the comparatively slender masts with one fighting top each and the two high smokestacks, the cross section of one of which is circular, while that of the other is oval.—For our illustration and the accompanying description we are indebted to the Illustrirte Zeitung.



THE NEW GERMAN CRUISER "PRINZ HEINRICH."

The other four stand in single revolving turrets one story above the casemate. The two forward ones of these can also fire dead ahead, and the two after ones dead astern. The lighter guns (8.8 and 3.7-centimeters) are placed on the upper deck and on the superstructures in such positions that each single one has as large an arc of fire as possible. Of the 3.7-centimeter (1½-inch) machine guns, some have been placed in the tops of the two fighting masts.

The torpedo armament consists of four tubes for 45-centimeter torpedoes, three of which (one bow and two broadside tubes) are submerged; only the stern tube protected by the belt armor lies above the water line. In the ships of the "Freya" class the stern tube is lacking.

As regards armor protection, the "Prinz Heinrich" differs from the vessels of the "Freya" class, especially in the belt armor, which extends over the whole length of the ship and is 100 millimeters thick on the water line. The turrets of the heavy guns have an armor thickness of 6 inches, as against 4 inches in the case of the other aforementioned cruisers. Of equal thickness as with these, viz., 4 inches, is the armor protection of the forward conning tower and of the 15-centimeter (6-inch) guns (casemate and turrets), but in the "Freya" class the casemate of the "Prinz Heinrich" is entirely lacking. The light guns only possess the protection, customary in the German navy, of protective shields affixed to the carriage bodies proper. Naturally all the ammunition shafts leading to the gun mounts are also armored.

PAINTS WITHOUT OIL.

To dwell on the inconveniences occasioned by the employment of oil in artistic painting would be surely useless, if contemporary painting were not compared with that of past ages. But as we are often astonished by the greater changeableness of modern paints than that of those of the Renaissance, some words on the old processes will throw light on the subject.

The origin of painting with oil has been closely studied by historians of art, as well as by chemists, and even by physicists. Some, and among them M. Charles Henry, place the first attempts in the time of Cæsar; others believe they see in Theophilus Heraclius, or especially in Jean Van Eyck, the originator. The last hypothesis brings us down to the fifteenth century. Still the process was theoretically applicable, but a distinction was not made between pure oils and oils chemically impure, and when the new method was put in use, it was soon remarked that the difficulties were as great as before. The colors changed rapidly; the drying especially required much time. It was necessary to wait for months before varnishing works, which no longer exhibited the same brilliancy in coloring. So painters did not abandon their old processes, and the "pharmaca," resinous matters mixed intimately with mineral colors, remained in honor.

Why should the mixture of sarcocol, bitumen, solid or dissolved, and mastic or incense have been abandoned, when they answered for the painting known under the name of "encaustic with the brush," restored by Regueno? Were not frescoes produced with lime added to earthy colors, which are esteemed today? This was the painting with distemper, which was made by preparing the colors by trituration with an emulsion of gluten, and covering the whole with a light varnish of mingled oil, resin and wax.

Meanwhile, researches continued, and it was soon perceived that the difficulty caused by pure linseed oil would be surmounted if drying linseed oil is used. A great step was made in advance, and great advantages secured. This process was deemed the only one possible until nearly our own times. Nevertheless, the ready oxidability, the rapid sulphuration, were recognized as strong objections to the employment of siccatives.

But in default of more convenient substances, painting with oil was at times continued. To-day the oils employed preferably are linseed oil, nut oil and poppy oil, according to the class of paints. Now, as these substances have no drying properties, it is necessary to employ siccatives suitable for each tint. When a deep shade is desired, colored driers, such as litharge, may be employed. If a light shade is sought for, lead hydrosilicate, the "drier diamond," substances impalpable and colorless, are employed.

But this method, advantageous with reference to manipulation, is defective, when its many inconveniences are considered. Oil is a body perfectly oxidizable and sulphurable. So, when a paint is exposed to atmospheric influences, to various exhalations, to air confined and not often renewed, the colors change completely; the whites become yellowish, and brilliant blacks a dull gray. The effect is still worse if the painter employs colors with a base of ceruse (lead hydrocarbonate, chromate, oxides and other salts of lead). The picture or the fresco is covered in a few years with a yellowish gray fog of uniform shade.

These different inconveniences have lately excited the attention of industrial chemists. To succeed in excluding oil and varnish in painting, to discover substances which would obviate their inconveniences, would in truth mean a revolution in pictorial art, but it would also mean durable and constant productions.

Let us then examine the numerous attempts which have been made lately, and which, it must be acknowledged, have not been attended with the results hoped for. There are, first, the experiments at Lyons with gelipot and alcohol. These processes are based on the compositions of resins and oil of turpentine. But the employment of these products is not easy, since they can be prepared only as needed, and the matter drying very quickly, it would be impossible to apply it with a brush.

Strong claims have been put forth for enameling or porcelain paints, specially designed for covering interior mural surfaces and furniture. But it is difficult to estimate them correctly, since it is difficult to employ the brush. If they are only colored varnishes, the question is not solved.

Although the brush cannot be used with such substances, another instrument may, perhaps, be employed. MM. Charles Henry and Cross indicate the employment of the *cestrum*, a sort of metallic pallet, for this purpose. But, without denying all the merits of such pigments, great delicacy in form and design cannot be attained. Certain painters who base art on the differences of tint, and certain amateurs, may be satisfied with them. But true artists object to

their employment, from their dull shades of color, their lack of fluidity, and their liability to dry too rapidly.

Since these different processes have not yet given satisfaction, let us examine another that has been recommended. We refer to potato painting, a sort of aquarelle. The composition of the pigment is recent and due to M. Cadet Devaux. Its constituents are potatoes, 1 kilogramme; Spanish white or other coloring matters, 2 kil.; ordinary water, a sufficient quantity. The potatoes are peeled, boiled, mashed and mixed with a quantity of water equal to about half the volume to be used during the operation. Then the Spanish white is added; care having been taken previously to dilute it separately in a quantity of water equal to that employed for the potatoes. When the whole has been mixed intimately it is passed through a sieve, in order to separate the lumps which may have been formed. A substance is obtained, which is employed like ordinary distemper. When the work is well done, this paint adheres sufficiently to wood and walls not to scale off or to fall into dust; still, it is attended with many disadvantages. The manufacture is difficult, and it can only be employed on interiors and in places free from moisture. It is only a distemper paint.

Skin glue is also used for distemper, with Spanish white that has been infused in water; or some other colored earth. To preserve the shade, which very soon changes if this substance is used alone, care is taken to add with chalk or yellow ocher a little red ocher or English red (iron tritoxide), which imparts a suitable tint. But this, too, has defects. The skin glue often producing a coloring matter, which becomes granulous and greatly impairs its durability.

In speaking of distemper painting, we referred to gluten. Quite an economical varnish can be prepared with it. By dissolving gluten in alcohol and adding gum lac, a product is obtained which surpasses in brilliancy the varnish usually employed. The composition consists of alcohol, 1 liter; gum lac, 16.50 grammes; gluten, 62,50 grammes. While 1 liter of the ordinary varnish will cover a surface of 11 square meters, the new varnish will cover in less time a double surface and will render the veins of the wood more visible.

For some time gelatin varnish has also been employed. It adapts itself to all forms and will give all shades of color. It imparts the glazed polish to the paper used for pamphlet covers and other purposes. Still, M. Gaugain has shown that gelatin varnish is of different application; that it is permeable to moisture, which swells and softens it, and that perspiring fingers, touching it, will leave ineffaceable impressions.

We have passed in review different pigments and varnishes and have noticed their defects. Art, subordinated to coloring matter, cannot be truly expressed so long as the employment of these substances is subordinated to that o linseed oil or other oils of varied quality.

Paints without oil almost necessarily contain a volatile solvent; by this we mean, not a liquid which evaporates as rapidly as ethyl oxide (sulphuric ether), or as petroleum ether, but substances similar to oil of turpentine or petroleum. Paints without oil are of course less oxidizable or sulphurable than those that contain oleaginous products. The reason can be readily understood. The solvent escapes in a few hours, and consequently cannot react on the coloring matter and give rise to products of a different color.

Paints without oils do not resist the employment of "siccatives." If the ordinary industrial signification is given to this term, a signification rather arbitrary, the drying quality and the adherence of these substances proceed naturally from the volatilization of the solvent; nevertheless, there is no proportionality. Certain solvents essentially volatile do not cause any adherence. Others, on the contrary, act similarly to caoutchouc. Sometimes mineral substances other than coloring matters are added to these adjuncts of the paint. We will briefly explain the reasons.

The adherence proceeding from the evaporation of the solvent is oftentimes slight, so that the coloring matter is completely removed. There is a scaling off or a swelling when the solvent is very volatile, and when the evaporation increases very rapidly on account of the heat. To avoid such serious disadvantages, gummy or gelatinous substances are added, such as those proceeding from the treatment of bones by acids only slightly concentrated, of caoutchouc, or of resinous products; in a word, substances having the effect of strong glue. Evidently, some difficulties occur in the drying of these. How can they be surmounted?

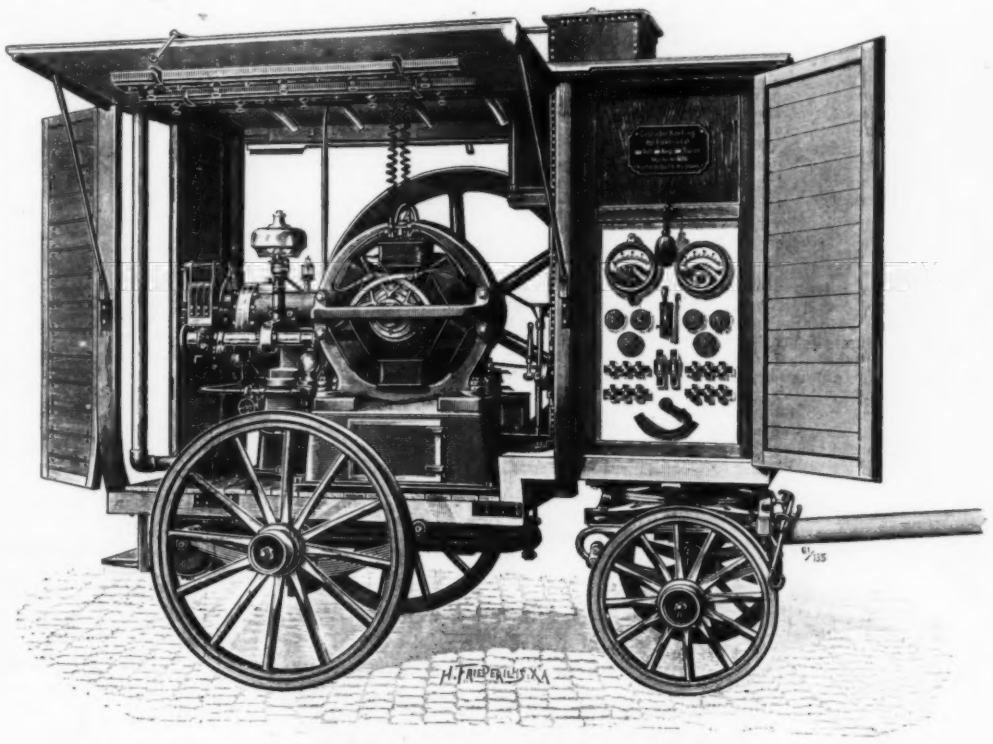
Certain mineral matters, such as the salts of lead, combine with those adhering products and yield a kind of resinous soap. A hardening results, which is at times unfavorable for the artistic employment of the paint. Gelatins may also be precipitated. Whatever may be the operative method, the bodies which cause the hardening ought to be considered the siccatives of "oilless" paints, siccatives very different from matters which render oils siccative.

Other mineral bodies, porphyrized glass for example, act mechanically. They separate into small particles the resins or gums which enter into the composition of these paints, and impart by reflection on their crystalline faces a brilliancy at least as great as that of enameling paints.—Translated from the Revue de Chimie Industrielle.

PORTABLE ELECTRIC STATION.

In the course of a lengthy article on "Electricity in Agriculture" Grossbetrieb describes the portable electric station shown in our illustration as follows:

Even in places to which it is impracticable to conduct the electric current from a nearby power station this kind of energy need not be renounced. Our illustration shows a so-called illumination carriage of the firm of Koertig Brothers. It is a complete portable electric station with benzine motor, dynamo with direct coupling, recooling arrangement, switchboard, etc. The motor is fitted with precision steering and electrical ignition, and works very accurately and almost noiselessly. Since the use of alcohol is cheaper in the country, alcohol may be used in place of benzine.



PORTABLE ELECTRIC STATION.

STUDEBAKER WIDE SPRAYING ELECTRIC CAR.

THE Colorado Springs and Suburban Railway Company, in pursuit of its aggressive policy for improvement, has installed the latest model of an electric car sprinkler, manufactured by the Studebaker Brothers Manufacturing Company, of South Bend, Ind.

The difficulties arising in the keeping of the streets well sprinkled are more peculiar here than in any other city of the United States. There is no other city with such universally broad thoroughfares, nor anywhere is there as little necessity of paving. Coupling with this the bright rays of the sun, dry air and wind storms, together with the necessity of sprinkling the year around, there is a demand for a machine that will throw a body of water, with a sufficient force to spray to the curb, in the least time and with a saving of running expense. In its construction this car covers as many of the points as it is possible to do. To the passer-by it has the appearance of the regulation street car, and when not sprinkling, due to its being finished in the company's regulation colors, it is not particularly noticeable, except that shutter windows are used instead of the glass. Both ends are full glass vestibule, the motorman operating in his usual position, protected from gales of wind or frigid temperatures. Built on a single truck gear, the car is run by two sixty-horse power motors of General Electric type, the load being carried on graduated springs. A steel

THE STUDEBAKER WIDE SPRAYING ELECTRIC CAR SPRINKLER.

tank carrying 2,600 gallons of water is inclosed with sufficient room for a person to pass from end to end on either side.

The objectionable feature of the swinging arm, used on the car sprinkler operated in this city a few years ago, is overcome by the spray being thrown from two sprinkling heads, found on either side, about the center near the trucks. The water is forced from these heads by two individual force pumps, run by a thirty-horse power motor, and located at the end of the car. The amount of water thrown, together with the width of the spray, is governed by levers at either end. An emergency brake is also supplied for quick work in the passing of a moving vehicle, or running at high speed. The sprinkling apparatus, as well as the car, can be operated at either end. A third sprinkling head is located in front of the center of gear for the flushing of the tracks or between them.

In the test with the car standing a spray of water seventy-eight feet in width from center of track was thrown with the use of one head, while with both sides open a distance of 120 feet was covered. A still further test was the run on Pike's Peak Avenue, when, at a speed of about ten miles an hour, this exceptionally wide avenue was satisfactorily covered.

The machine will unquestionably meet all of its requirements, and is a credit to its builders, as well as its purchasers.—Municipal Journal and Engineer.

ELECTRIC FURNACES.*

By BERTRAM BLOUNT.

THE function of an electric furnace is to produce a temperature of a degree, or in a place unattainable by other means. The first proposition is proved by the fact that such substances as silicon carbide or carbon boride cannot be prepared by any other method than the use of the electric furnace, because they need for their formation a temperature higher than 2,000 deg. C.; the second is illustrated by the incandescence of the filament of a common glow lamp, inaccessible to ordinary methods of heating. The rough limit of temperature set (2,000 deg. C.) depends on the point naces, and these at their best give a temperature not greatly above the fusing point of platinum (1,775 deg. C.=3,227 deg. F.). We may conclude with fair approximation to accuracy that the highest temperature attainable from fuel is at or about 2,000 deg. C. No mechanical method of producing high temperature has been tried, but this procedure, which must necessarily be ballistic, is of much theoretical interest; its realization is more than dubious, but by the use of electrical energy all this is changed. There is still a limit of temperature, but it is higher. The whole output of a large prime mover can be expended in a small box so well isolated that its loss of heat is insignificant. The natural and inevitable result is the production of an exceedingly high temperature. The limit to this is set by the loss by radiation and conduction of heat from the box which may be made relatively small, and by the volatilization or decomposition of the electrodes and the materials inclosing the furnace cavity. The advantages thus gained have been turned to excellent account industrially and in chemical research.

No dissertation on the subject of electrical furnaces would be in any sense adequate without due reference to the work of Moissan. This bold and original chemist has done more to put our knowledge of reactions at high temperatures on a sound footing than any of his predecessors or contemporaries. He has concerned himself exclusively with the scientific side of this question, and his work is free from all taint of money-making. But those who are less loftily disposed will find in his researches the seeds of a rich harvest. Moissan's book, entitled "Le Four Electrique," contains a systematic record of his investigations, and describes the various admirable furnaces which he has devised and the results attained by them. By their aid Moissan has succeeded in fusing, volatilizing and crystallizing such refractory materials as lime, magnesia, platinum, silica, zirconia and carbon; he has studied the allotropy of carbon, and incidentally produced the diamond; he has prepared a whole series of novel carbides, borides and silicides, and on the basis of his experiments he has advanced a new and sagacious theory of the origin of petroleum, a matter which, it can be turned to account. Artificial corundum would then stand toward fused alumina prepared by the "thermite" process, much as diamond does to carbonado. The case of carbon and its conversion to the octahedral form (the diamond) is too trite for repetition, but the inventor who succeeds in preparing masses of this very hard substance in a determined shape, and not brittle like the natural crystals, is certain of reward. Substances both hard and strong are rare; substances hard, strong and unattackable by common agencies still rarer; the diamond is very hard, fairly strong, and completely unattackable except by oxygen and one or two solvent metals, e. g., iron and platinum at a high temperature; it is evidently a desirable material.

A substance which may sooner be made in quantity and put into use is fused silica. Prof. Boys first demonstrated the great possibilities of this material. Mr. Shenstone has shown that quartz fused before the oxy-hydrogen blow-pipe is in all ways superior to glass as a transparent and refractory material for the construction of apparatus. At present tanks of glass of fair size can be cast in spite of the brittleness due to its internal tensions. With quartz fused by the ton, and similarly cast, it should be possible to prepare great vessels indifferent to sudden changes of temperature and practically permanent under the most severe conditions. Investigations in this direction are being prosecuted by Mr. R. S. Hutton, who had achieved some remarkable results. I will not trespass on his right to make known his success by attempting in this paper to do more than refer to his activity.*

Proceeding with our catalogue of useful substances, graphite may be mentioned. Natural graphite is a gritty and inferior material, as may be seen from the following figures:

MINERAL MATTER, ASH.

	Per Cent.	
Cumberland	7.35	Quoted by Percy.
Ceylon	15.50	
France	7.72	
Bavaria	58.00	
Artificial (Kish)	9.30	
Australia	54.34	B. B.

The nature of the ash is important as well as its

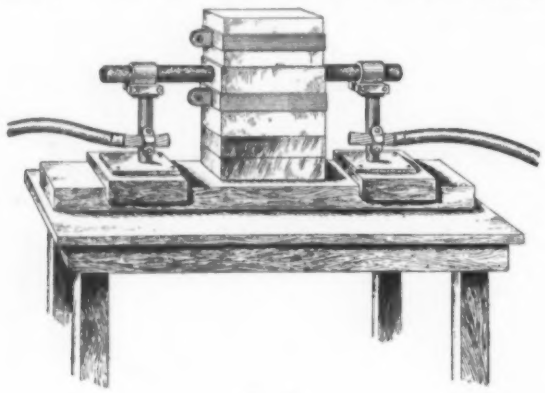


FIG. 1.

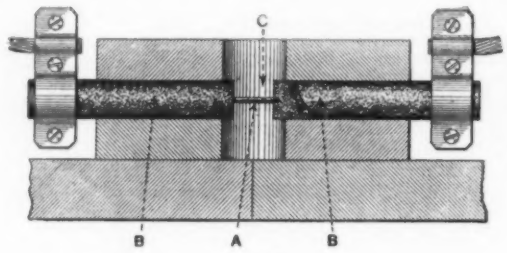


FIG. 2.

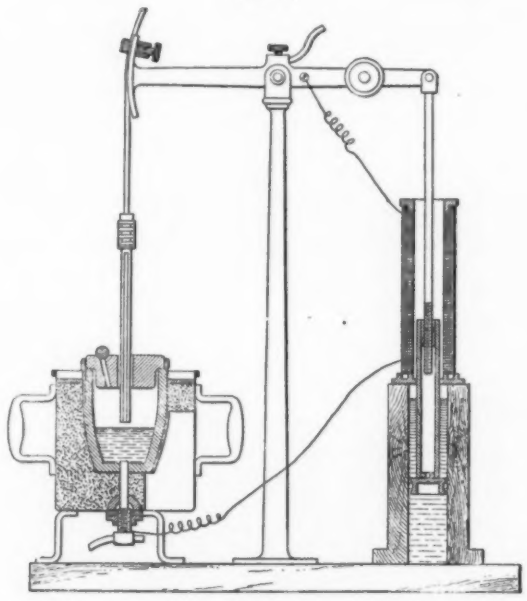


FIG. 3.

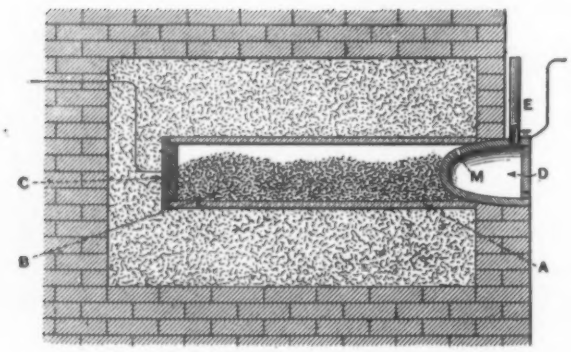


FIG. 4.

of dissociation of all compounds of carbon and hydrogen with oxygen. If it were possible to cause oxidation of these fuels to proceed irrespective of temperature, greatly higher values would be obtained. For example, if we assume that carbon can combine with oxygen at all temperatures to form CO_2, and that the specific heat of the gas determined at moderate temperatures remains constant, we have as the calculated maximum attainable temperature the astounding figure of 10,178 deg. C.=18,352 deg. F. Unfortunately we cannot separate the products of combustion from the heat which they produce in such a way as to remove the products and leave the heat behind as an entity distinct from matter. Thus it comes about that these products of combustion reach their dissociating temperature far below that calculated from their heat of combination and the specific heat of the product, and however we may urge our furnace our maximum is fixed. As far as I know, this maximum has never been determined experimentally. It is probable that the nearest approach to the limit would be attained by burning retort carbon in oxygen in a furnace fed with a blast of the gas and well jacketed. With a similar furnace fed with air, and necessarily cooler, it has been found possible to volatilize quartz. We have no evidence that quartz is volatile at any temperature reached in industrial non-electrical furin spite of the labors lavished on it, has been and is a problem for the chemist and geologist.

Novel Industrial Products.—Looking through Moissan's work I have picked out those substances and reactions which seem to me most likely to become of industrial importance. We may dismiss for the moment the formation of calcium carbide and silicon carbide (carborundum), for they are already commercial products, and turn our attention to other bodies which are as yet not made industrially in the electric furnace. Alumina is one of those oxides which fuse and volatilize in the electric furnace; on cooling it crystallizes as corundum, or, if a trace of chromium is present, as ruby. The latter has been prepared in better crystals by the process of Fremy and Verneuil, which consists in heating a mixture of barium fluoride with alumina, containing a trace of potassium bichromate. Seeing, however, that the electrical method has only been indicated, and not systematically studied, it may well be that if the proper conditions were ascertained the efficiencies of the two processes would be reversed. Much wealth might be secured by manufacturing rubies, flawless, or with the conventional flaws, of large size, for they are greatly esteemed by the unthinking, but evidently the manufacture would have to be conducted secretly to continue profitable. The preparation of corundum, on the other hand, would have permanent industrial importance, because, although the raw mineral is fairly abundant, it needs winning and grading before amount; a hard cutting siliceous ash will make graphite useless as a lubricant, and the merit of some of the brands esteemed for this purpose no doubt rests on their mineral contents chancing to be soft or even lubricative. But with artificial graphite this good property could be procured by design instead of accident. All forms of carbon, crystalline or amorphous, are converted into graphite at a temperature sufficiently high; graphite may be regarded as the final stable form of the element. It follows that artificial graphite may be manufactured by heating directly any kind of carbon sensibly free from mineral matter. But it may well prove that in practice a method, differing from this in principle, will be found more advantageous. This method consists in dissolving carbon in a fused metal until it is saturated at a high temperature; on cooling, a portion of the carbon is thrown out of solution as graphite. The commonest example of this reaction is the formation of "Kish" from cast iron, but the method is quite general. Aluminium, manganese, nickel, chromium, tungsten, molybdenum, uranium, zirconium, vanadium and titanium are examples of metals which are capable of being supersaturated with carbon, and on cooling of liberating a portion of it in the form of graphite.

Crystallization from a supersaturated solution of carbon in a metal, or its carbide, may be supplemented

* Paper read at the Manchester section of the Institution of Electrical Engineers.

* Mr. Hutton's experiments have lately been described in a Paper read before the Manchester Literary and Philosophical Society.

by providing the metal with some other substance with which to unite, and thus displacing the carbon. The commonest instance is the displacement of graphite from cast iron by silicon. All engineers know that gray pig run down in a cupola becomes harder, but not everyone may be aware that this is due to selective oxidation which tends to eliminate silicon, and thus to allow the recombination of the iron with carbon previously displaced by that silicon as graphite. Conversely if silicon is added to iron saturated with carbon a portion of the carbon will be displaced and appear as graphite. There are, therefore, three methods for the manufacture of graphite by means of the electric furnace: (1) The direct conversion of carbon to its ultimate stable form at a very high temperature; (2) the crystallization of graphite from a supersaturated solution of carbon in some suitable metal; and (3) the crystallization of dissolved carbon from its metallic solution by the addition of an element such as silicon or boron capable of displacing it. The preparation of graphite on an industrial scale has already been attempted by Acheson, and from the published descriptions of his process it appears that he uses either the second or third method. Acheson, in his U. S. A. Patent No. 568,323, claims broadly the manufacture of graphite by the decomposition of a carbide, a claim which clearly is untenable because the decomposition of a carbide and the production of graphite thereby have been known for many years. He appears to have observed that various carbides will dissolve carbon, and on cooling will deposit the carbon as graphite, and maintains that the conversion of nearly pure carbon, such as anthracite, into graphite is dependent on the successive formation and decomposition of carbides of the metals and non-metals constituting its ash. At the same time he fails to take account of the fact that the ultimate goal of all forms of carbon when sufficiently heated is graphite, irrespective of the particular form of carbon used or special method of conversion. It must, therefore, be conceded that Acheson has merely applied methods described long before and well known to all interested in the subject. Whether Acheson's methods are followed or not, it is probable enough that artificial graphite will eventually displace the natural material. Graphitized carbons are also manufactured, and these, it appears, are made by heating ordinary carbons electrically to a temperature high enough to convert them partially into graphite.

A number of refractory metals, such as chromium, tungsten and molybdenum, can be readily prepared in the electric furnace, and I should have been disposed to set these down as among its coming industrial products were it not for the fact that some, at least —e. g., chromium—can be prepared more rapidly and in greater purity by a purely chemical method, viz., by the reduction of their oxides by aluminium. There seems no reason why this elegant process should not be applied generally in all cases where there exists or can be created a demand for the refractory metal. But although the electric furnace is thus put momentarily in the background, an electrical method is still a necessity, for the only process for making aluminium which is at present feasible is electrolytic. When it is generally realized that aluminium may be regarded as a powerful, compact and non-volatile fuel, that metal will be manufactured, perhaps somewhat impure, but cheaply and in quantity for a variety of purposes quite distinct from those which it serves as a metal in the arts.

The last substance which I shall mention as a typical product of the electric furnace, and possibly destined to contribute to "the use and convenience of man," is carbon boride, CB_6. The chief industrial merit of this substance is its extreme hardness, which approaches that of the diamond, and although its mode of synthesis is a little cumbrous—requiring, for example, the previous preparation of elementary boron—yet there is nothing that need deter the experimentalist anxious to obtain a novel product for the market.

Types of Electric Furnaces.—There are two types of electric furnace, the arc and the resistance furnace. Both are used in industry. The simplest effective form of arc furnace is that devised by Moissan, shown in the accompanying figure (Fig. 1). It consists of two blocks of chalk carefully dried and carved out so as to form a cavity in which a carbon crucible can be placed. Massive carbon electrodes pass into this cavity, and the arc formed between them plays over the hearth, heating the material to be treated in the manner of a common reverberatory furnace. The chief merits of the furnace are its extreme simplicity and the refractoriness and low conductivity of its materials. In the form shown, this furnace is necessarily discontinuous, but the complete inclusion and surrounding of its charge give it much advantage. Where contact of the charge with the electrodes is not harmful it may be possible to make this furnace continuous. There is no reason why a charging and a tapping hole should not be provided, in which case the run might be sustained. The natural use of a furnace of this type is for the production at a high temperature of metals, alloys, carbides and similar fluid bodies which are too conductive to allow of easy heating in a resistance furnace. The application of the high heat of combination of aluminium to the reduction and fusion of refractory metal limits the utility of this class of furnace, and at the present moment it is used only in one industry with which I am acquainted, and then in a modified form. I refer, of course, to the manufacture of CaC_2.

A typical resistance furnace is that devised by Borchers, and shown in the figure (Fig. 2). It consists of a slender carbon rod, *A*, supported between two stout carbon rods, *BB*. The small rod bridges the cavity, *C*, which can be filled with the material to be treated. On passing a sufficient current the rod is raised to a high temperature, and the charge is heated from its very center. This class of furnace is evidently generally adaptable, provided that the product of the action of the high temperature—e. g., a metal—does not collect and form a good conducting connection between the large carbon rods. The type is represented by the furnace employed for the manufacture of carborundum.

These two types of furnace—viz., that in which there is a definite arc and that in which the heating is effected through a core of high resistance, or the charge itself—will be found to represent in one class or the other all the industrial furnaces about to be described.

History and Development of the Electric Furnace.—It may be permissible to trace the development of the modern electric furnace. Except in the laboratory, where it had been employed with success, notably by Berthelot, who first synthesized acetylene from carbon and hydrogen at the temperature of the arc, no noteworthy attempt to apply this enormous and dirigible source of heat to the accomplishment of chemical reactions had been made until about 20 years ago, when the experiments of Siemens were published. In his paper before the body then known as "The Society of Telegraph Engineers," Siemens laid down with clarity and precision those principles on which the successful operation of the arc furnace depends. In this notable communication he points out that the limit of temperature attainable by the use of the oxyhydrogen jet, or by his own regenerative furnace, is ultimately set by the point of dissociation of water and carbon dioxide; that the temperature in an electric furnace is independent of this limit; that in the electric furnace fusions may be effected in an atmosphere uncontaminated by the ordinary products of combustion; finally, that the expenditure of heat is economical. Having shown this to be true on theoretical grounds, he proceeds successfully to experiment, and states: "In working with the modified medium-sized dynamo machine, capable of producing 36 webers of current with an expenditure of 4 horse power, and which, if used for illuminating purposes, produces a light equal to 6,000 candles, I find that a crucible of about 20 centimeters in depth immersed in a non-conductive material is raised up to a white heat in less than a quarter of an hour, and the fusion of 1 kilogramme of steel is effected within, say, another quarter of an hour, successive fusions being made in somewhat diminishing intervals of time." He proceeds to compute the energy actually expended, and to compare this with the calculated number of calories necessary to fuse a given weight of steel, and finds that there is an efficiency of 33 per cent, by no means a bad return in so small an apparatus. He further shows that a properly designed electric furnace, though necessarily falling behind a good regenerative gas furnace in economy of fuel, is more economical than furnaces of the type used in Sheffield for the manufacture of tool steel and fed with solid fuel on a hearth. He sums up the case for the electric furnace in words that are well worth repeating to-day. It has, he says, the following advantages in its favor: "(1) That the degree of temperature attainable is theoretically unlimited; (2) that fusion is effected in a perfectly neutral atmosphere; (3) that the operation can be carried on in a laboratory without much preparation, and under the eye of the operator; (4) that the limit of heat practically obtainable with the use of ordinary refractory materials is very high, because in the electric furnace the fusing material is at a higher temperature than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it." The Siemens electric furnace had the electrodes arranged vertically, as shown in the accompanying drawing (Fig. 3). As the charge fused, the arc played between it and the upper electrode. The regulation of the position of the upper electrode was effected by a solenoid and a dash-pot similar to the arrangement then in use for arc lamps. A later pattern had the electrodes inserted through the walls of the crucible horizontally. The Siemens furnace does not seem to have received the application which its inventor had reasons to expect, viz., the industrial fusion of refractory metals, and it does not appear to have been adapted to the reduction of their oxides and the preparation in this manner of refractory metals such as chromium and tungsten in reguline masses. But little more of importance was done in the development and application of the electric furnace until 1884, when the Cowles furnace was invented. This was a resistance furnace, but instead of there being a continuous rod of carbon bridging the space between two massive conductors, also of carbon, as in the typical resistance furnace due to Borchers, and illustrated here, the Cowles furnace used the charge itself as the resistance material. How this was arranged is shown in the accompanying figures (Figs. 4, 5, 6 and 7).

The first figure is interesting because it represents an apparatus adapted for the process of zinc reduction and distillation by electrical means—a process which, although certainly rational and probably practicable, has, as far as I know, never been established on a manufacturing footing. The fire-clay retort, *A*, is protected from loss of heat by being embedded in refractory non-conducting material, *B*. The charge of zinc oxide and carbon serves as the resistance material to be heated by the passage of an adequate current between the carbon plate, *C*, forming the end of the retort and the graphite crucible, *D*, serving both as a closing plug and as a condensing chamber for the zinc distilling from the retort through the side hole, *M*. Gases—e. g., carbon monoxide—generated during the reduction of the zinc oxide escape through the pipe, *E*. No account has come to my notice of the reason which prevented this furnace being brought into use. It is probable that it failed because of the difficulty of so preparing the charge that it should consist on the one hand of a mixture of zinc oxide and carbon intimately mixed for reduction, and on the other should constitute a granular semi-conductive mass suitable as a resistance material, and capable of being uniformly heated by the passage of the current. Further, it is evident that as the charge was worked off, its composition and physical structure would be progressively altered by the distillation of the reduced zinc, and the removal of an equivalent of carbon as carbon monoxide, and its electrical resistance would, therefore, be continually varying; a large excess of carbon would in any case be necessary, for otherwise toward the end of the run one could hardly hope to have a continuous uniform semi-conductive bridge between the two carbon ends of the retort. Such working difficulties may well have caused the abandonment of the process and have delayed the realization of a promising application of the electric furnace of the resistance type. The second figure represents in perspective and in section the familiar form of what is commonly known as the Cowles furnace. A modification less well known is shown in Fig. 7.

The essentials of both are the provision of a core of resistance material consisting of a mixture of ore with carbon to serve the double purpose of conduction and reduction, and the surrounding of this core with a material highly refractory and at the same time a bad conductor of heat and electricity. Such a material is granular charcoal. In the drawings shown, similar parts are indicated by the same letters. *A* is a firebrick casing, *B* is the protecting layer of granular charcoal, and *C* is the semi-conducting charge. The carbon conductors by which the current is led into the furnace are shown at *D D*. In the second type of Cowles furnace hoppers and a tapping-

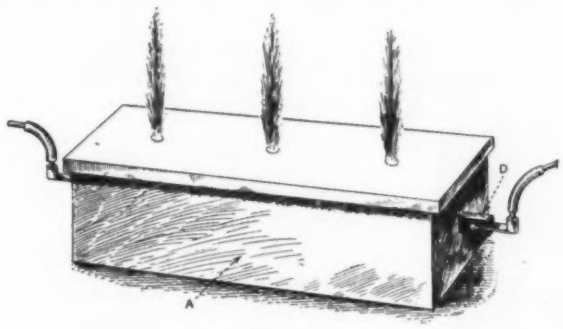


FIG. 5.

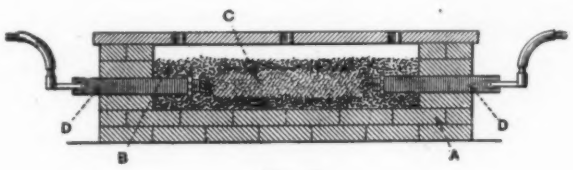


FIG. 6.

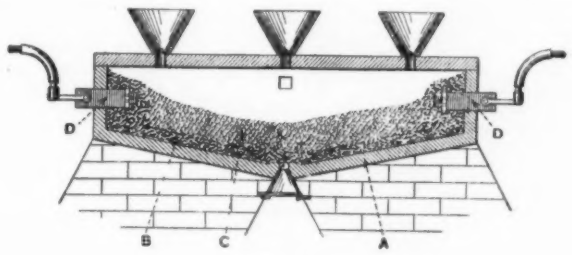


FIG. 7.

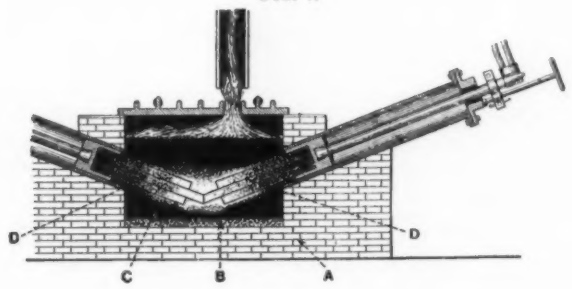


FIG. 8.

hole are provided. They serve not merely for charging and drawing, but also for altering at any given point the amount of resistance material on the hearth, and thus of controlling the heating effect of the current and causing it to be approximately uniform from end to end. The idea of making the charge itself act as the resistance for converting electrical energy into heat energy precisely at the place required was extended by the Brothers Cowles in the best-known form of their furnace, viz., that which was employed for making aluminium alloys, especially those with copper. Here the granulated copper mixed with the charge of alumina and carbon served as a semi-continuous conductor the contact surfaces of the constituent parts of which offered sufficient resistance to insure the production of much heat when a current was forced through. The ultimate outcome of their ingenuity is shown in the figure (Fig. 8) representing a furnace for making aluminium bronze. The parts are lettered similarly to those of the previous illustrations. This type of furnace was successfully used for some years, but at the best it would only produce aluminium alloyed with copper and generally containing iron and silicon as impurities. The Héroult apparatus, which produces unalloyed aluminium, soon replaced the Cowles furnace even for alloys, because it was found to be better to prepare a definite alloy by mixing the pure metals in an ordinary furnace as is done for brass, gun-metal and a host of similar alloys. It is interesting to note that in the series of Cowles patents there is one describing the use of charcoal with a wash of lime over the fragments composing the lining. The idea is elegant, and in the days when it was first set forth calcium carbide was barely known. If the packing of charcoal reached a temperature sufficiently high—and it probably did—there remains the doubt whether its limed surfaces would not be converted into calcium carbide and thereby become fusible and conductive.

The history of the electric furnace is very short and simple. In the foregoing is set down everything essential. On the one hand we have the Siemens furnace with its arc playing upon a refractory substance, and, on the other, the Cowles furnace without an intended arc (though many may occur) operating through a resistant core. All electric furnaces proper fall into one category or the other.

Having thus traced the origin of the two dominant types of electric furnace, I will give a brief description of a few examples belonging to one or the other class which exhibit points of individuality and interest.

(To be continued.)

THE MANUFACTURE OF ARTIFICIAL LIMBS.

SUBSTITUTES for lost extremities are of the utmost importance, and the replacement of the upper extremities constitutes an even more urgent demand than that of lower limbs.

Most of the inventors of the 17th century, so far as we are acquainted with their mechanisms, required the assistance of the healthy hand in order to move the artificial one.

An apparatus was perfected in the last century (19th) by which the movements of the stump were utilized. In 1812 the dentist Ballif, of Berlin, acting on this principle, constructed a tin hand weighing only five hundred grammes; the flexion of the fingers and of the wrist was produced by the action of springs. The illustration shows how the straps which kept Ballif's hand in position were worn. One strap surrounds the breast like a belt, another passes from front to back across the shoulder like a suspender, and is joined to the belt encircling the breast. At the point where the suspender rests on the shoulder another strap is fastened, which can be drawn across the under part of the upper arm. To this strap, as well as to the girdle, cords are attached, reaching to the fingers. When, for instance, the arm is lifted and the elbow joint extended, the fingers are stretched. As soon as this arm movement ceases the fingers are brought back to their former position by the action of the springs.

In 1836 Ballif's idea was followed, though in a reverse course, by Karoline Eichler, of Berlin, who also invented an artificial arm. While in Ballif's apparatus, when the arm is hanging down, the fingers, yielding to the pressure of their own independent springs, are completely flexed, Karoline Eichler constructed her mechanism in such a way that when the arm was pendant the fingers were extended, and on raising the arm the cord which reached to the fingers was drawn. The fingers consequently were closed, so that they could take hold of and lift objects weighing as much as eighteen pounds. Besides, with the assistance of the other hand, every finger of the artificial one, separately or together, could be placed in any imaginable position. Karoline Eichler, speaking of her invention, says: "With this hand it is possible to write, to sew, to embroider, to braid hair; and even to play the guitar."

Passing over several other inventions which offered very little that was new, we will speak of the two artificial arms of the Hollander Peetersen (1844). In these we find a very successful application of Ballif's principle. They served to replace the right forearm and the left upper arm.

The first of these, surrounding the upper arm, is an apparatus of splints having three leather straps, of which two carry a leather casing for the forearm stump; the third is underneath the end of the stump, inside the leather casing, and serves for the attachment of catgut cords reaching down and fastened on the back of the fingers. The fingers are flexed by means of springs, and the pulling of the strings overcomes the force of the springs, so that the fingers are extended. The strings are moved by putting forward the forearm at the elbow joint. When the dismembered person wishes to take hold of an object he extends his forearm in order to stretch the fingers. He then places his fingers near the object he intends to grasp and bends the forearm at the elbow joint. The tension on the strings relaxes, the fingers are again bent by means of their springs, and the object can be seized and lifted. When he wishes to release the object he puts forth his arm again. In Peetersen's construction for the left upper arm the fingers are likewise kept bent by the force of the springs. This apparatus consists of an upper arm casing jointed to a forearm case to which a hand is united by an articulation. The apparatus is attached, partly to the stump left by amputation, partly to a corset. From the back of the corset, on the right side near the shoulder, starts a catgut cord, which passes obliquely across the back and into the upper part of the artificial arm, taking a downward course until near the elbow articulation, where it crosses to the front over a wooden ball, *b*, and ends in the rear of the shell covering the

Detachable hand; hook; fork; plane; saw (with bayonet articulation for attachment on arm); screw ring; screw spoon; screw file.

FIG. 4.—INSERTABLE APPARATUS ACCORDING TO MATHIEU AND MASTER.

FIG. 2.—LOWER-LEG ANKLE JOINT. AFTER DR. DOUGLAS BLY.

FIG. 1.—ATTACHMENT OF A TOOL TO AN ARTIFICIAL UPPER ARM. DR. GRIPOUILLEAU'S METHOD.

FIG. 3.—ARTIFICIAL ARM WITH TOOL ATTACHED. DR. PETER'S METHOD.

forearm. Whenever the person moves the shoulder forward the string is drawn tightly, and consequently the forearm is drawn toward the upper arm. As soon as the shoulder returns to its usual position the tension of the spring, and at the same time the bending of the arm, ceases.

A second string, *d*, beginning a little above the lower end of the upper arm shell, crosses likewise in front of the ball in the elbow joint, but closer to the outside, then passes inside the forearm shell down to the back of the hand, where it branches out in order to reach

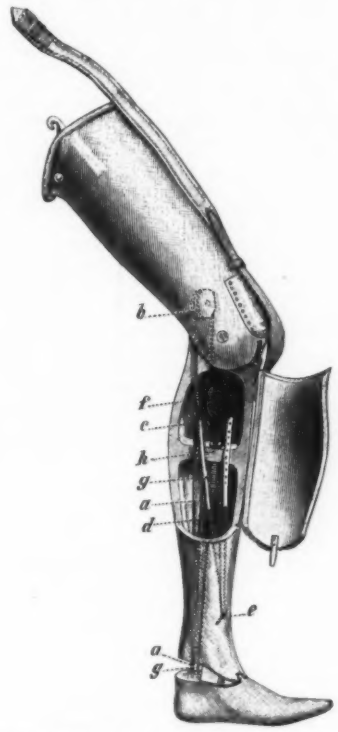


FIG. 5.—ARTIFICIAL LEG AND FOOT FOR CASES OF KNEE AMPUTATION, CONSTRUCTED BY WILHELM ERFURTH.

the back of the fingers. The mechanism for extending the fingers is like that employed when the right forearm is replaced. When the elbow joint is flexed the string is without tension, and an arrangement of steel springs about the phalanges of the fingers closes the hand, forming a fist. By extending the whole arm the string with its branches is drawn tightly, overcoming the force of the springs placed around the fingers, the hand is opened, and the fingers extended.

In order to stretch the fingers while the arm is flexed a third string is employed. This begins on the corset, *e*, by the side of the stump, passes under the shoulder articulation across a roller and enters the upper arm shell; then it passes downward, on the side toward the body, by the ball in the elbow joint, without touching it, and ends below near the hand by connecting with the string, *d*.

Whenever the elbow is moved but a little from the body this string draws tightly, so that, even though the forearm is flexed, the fingers may be extended without difficulty.

Sixteen years later an artificial arm was constructed by Charretière for the French opera singer Roger, who,

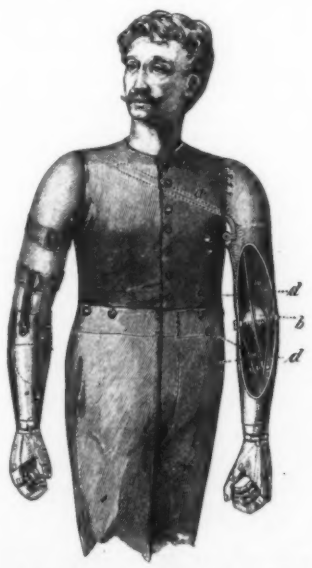


FIG. 6.—ARTIFICIAL ARMS, CONSTRUCTED BY VAN PEETERSEN, 1844.

in consequence of an accident while hunting, was obliged to have his arm amputated at the elbow joint. Until then the articulations for elbow and wrist were made of wood, but Charretière constructed them of steel. The different parts of the hand were likewise made of steel, and on all the fingers elastic spiral springs of copper wire were fixed. The whole was covered with wood. This was a very complicated contrivance. Nevertheless it was distinguished for its wonderful lightness, its manifold joints and great strength. With the upper part of the forearm rotary movements could be executed, so that Roger, armed with this apparatus, could without difficulty resume acting his parts on the stage.

At the same time Mathieu, a manufacturer of bandages, produced a mechanism for Roger in competition with Charretière. He constructed a forearm which moved in the following manner: Around the shoulder of the healthy arm a ring of leather is placed, so that it bends under the shoulder articulation. From a tension strap attached to the back of the leather ring starts a string of catgut which passes obliquely across the back over to the side where the arm is amputated, and here passes through an eye, which is placed outside on the upper part of the upper arm stump shell. It passes down in front of the shell to the vicinity of the elbow joint, to be attached here in three different

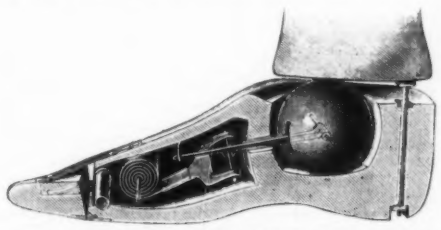


FIG. 7.—BALL ANKLE JOINT, BY PROF. ESMARCH.

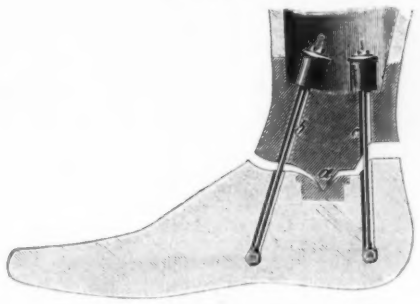


FIG. 9.—ANKLE JOINT CONSTRUCTED BY GEFFERS, BERLIN.

places. When it is intended to bend the forearm the healthy shoulder, surrounded by the leather ring, is moved forward, the string fastened to this ring crossing the back, passing through the eye on the upper arm shell, down to near the elbow, is drawn tightly, and the forearm assumes the desired position.

This apparatus renders it possible to bend the arm toward the person and away from it, and also to move the fingers separately.

In the year 1860 another artificial upper extremity was constructed by the French philanthropist Count de Beaufort. The Academy of Paris judged very favorably of the invention of Beaufort.

In this apparatus the arm is composed of three cases made of strong sole leather; one for the upper arm, another for the forearm, and the third for the elbow joint. The forearm carries a hand of linden wood carved in one piece, with a movable thumb, while the other fingers remain in a fixed and moderately bent position. The upper arm and forearm can be moved on each other by splints placed at the sides. On the inside of the lower end of the upper case is a movable hook, by means of which the case for the forearm can be placed at right angles. This flexion can only be produced by the healthy hand. In the bending the hook glides across an oblique piece of wood. As soon as the two arm cases are at right angles the hook gets fixed in the wooden piece. To loosen the hook the healthy hand is required.

The thumb is movable around a turning point on the hand by ball and socket, and is kept tightly pressed against the index and other fingers by means of a rubber spring. One end of this is fastened by a cord to the forearm shell, the other surrounds a pin placed in the thumb.

The manner in which objects are taken hold of is interesting. First it is necessary to draw the thumb away from the index finger. This is effected by a string attached at one end to the back of the thumb, passing from there on the inside of the forearm and on the rear of the upper arm through several eyes, and connecting with tension straps. The whole apparatus is fastened with leather straps to right and left shoulders. The string, passing on through an eye on the strap which crosses the back near the shoulder, on the side of the artificial arm, is thence continued over the back to the front of the body, where it is fastened to a trouser button. The moving of the hip forward exerts tension on this string. It pulls the thumb away from the index and the other fingers of the hand. When the object which is to be grasped lies between the thumb and the other fingers, the hip is drawn back to its usual position, the tension is relaxed, the thumb is no longer subjected to the action of the string, and by the

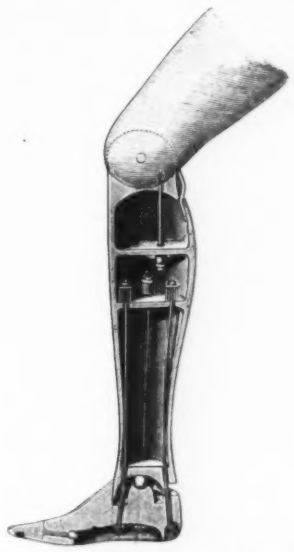


FIG. 10.—ARTIFICIAL LEG AND FOOT FOR CASES OF AMPUTATION AT THE THIGH, CONSTRUCTED BY WILHELM ERFURTH.

force of its own rubber spring it is pressed against the other fingers and the object to be grasped.

Not much later than Count de Beaufort's invention, José Gallegos constructed an artificial arm which possesses the great advantage of deriving its support and its moving power, not from the shoulder or breast of the healthy side, but from the stump of the amputated arm itself. Every movement which the stump is able to make is utilized as much as possible, with the aid of various materials, but especially catgut strings and spiral steel springs. A French journal among other things says that natural movements, such as grasping and lifting a glass, extending the arm, making gestures on the stage, or shaking hands, can be executed with wonderful facility.

Quite original was the contrivance of the instrument maker Oscar Dülisch, of Berlin, in 1877, of a substitute for the upper extremity. He utilized the movements of the amputated stump for moving the fingers by the pressure of the air; it was much like the so-called pneumatic telegraph. On the inside of the upper arm shell a large hollow rubber ball is placed, and near the wrist joint, inside the forearm, a smaller one. Both rubber balls are connected by a rubber tube. The fingers are kept extended by spiral springs. The mechanism is so arranged that, as soon as the smaller

FIG. 8.—ARTIFICIAL HAND OF DENTIST BALLIF (1812), BERLIN.

rubber ball is filled with air the pressure of the springs on the fingers is overcome, and the fingers are bent. The more the rubber ball is distended by air the closer is the fist. The air for this purpose is pumped in by pressing the upper arm stump against the breast, and thus compressing the larger rubber ball more or less. In this way the air is expelled from the rubber tube

and driven into the smaller rubber ball. As soon as the pressure of the upper arm shell, covering the stump, against the chest ceases the air returns into the larger rubber ball, and the fingers are stretched by the force of their springs. The straightening and curving of the fingers in this way as desired is wonderful.

This arm has also elbow articulation, and may be extended and crooked by the forward and backward movement of the shoulders. The apparatus is mostly of silver; it is attached by the upper arm shell to the stump, and by shoulder straps to both shoulders; these straps are securely joined by another strap, which crosses the back obliquely.

Dülisch himself wears an artificial hand and is constantly employed as a mechanic.

The inventions thus far described are not suitable for laborious occupations, such as striking a blow on an anvil, mowing with a scythe, digging with a spade, and leveling with a plane.

The credit of having first constructed an apparatus adapted to such purposes is due to the instrument makers Masters, of London, and Mathieu, of Paris.

While Masters contrived apparatus for shooting and horseback riding, in order to procure the pleasures of the chase for maimed persons in the higher social circles, Mathieu has adapted his mechanism to exclusively practical purposes for the working classes, especially carpenters and cabinet-makers.

Masters manufactured a knife containing three parallel blades. These have but one handle, so that at every cut of this knife meat is severed three times. Masters also made a hook for a rider to hold the reins with, and a metal fork for poising a gun, and other contrivances.

In Virchow's Annual we find a record of Mathieu's inventions.

"He (Mathieu) introduced before a commission a cabinet-maker having an artificial arm, who performed the different manipulations of his trade with the greatest agility, force and accuracy, taking from his pocket the various tools needed, which he attached to his artificial hand in the twinkling of an eye. He thus made use of a plane, a saw, a gouge, a gimlet, and a hammer just as he required them in his work."

In the same publication mention is made of an artificial arm constructed for agricultural laborers. Before a commission appointed for investigating these mechanisms this arm was tested on one man who had his upper arm amputated, and on another who had lost his forearm. These two men exhibited great strength and worked with strict accuracy. They dug in the ground, mowed with the scythe, plowed, threw earth high and far with a shovel, hitched horses to carriages and plows, and unhitched them again, and all this with tools and appliances which were borrowed at hap hazard from the agricultural exhibition at Billancourt. There was on this apparatus also an arrangement for holding a carving knife furnished with two handles; this also proved very satisfactory.

Credit for the construction of artificial arms is likewise due to the French country physician Dr. Gripouilleau, of Mont Louis.

Several illustrations of the mechanisms of Mathieu and Masters are herewith presented.

Dr. Gripouilleau's contrivances are generally arm shells made of lined leather for the upper arm or the forearm stump, which are fastened by straps in a suitable manner. On the forearm shell there is, for instance, a removable hand. In place of the hand various utensils may be inserted. In order to afford for these instruments, as well as for the artificial hand itself, a secure setting the lower end of the forearm shell is of metal. Either by screwing or by a so-called bayonet lock the different implements are attached. These include a knife, a fork, a spoon, a file, a plane, a hook, a suspension ring, and many others. One of our illustrations shows an apparatus constructed according to Dr. Gripouilleau's plans.

Extremely primitive appears the construction proposed by Count de Beaufort. A leather shell receives the upper arm stump; the rest of the upper arm shell is of wood and forked at the lower end, where the wooden forearm shell is attached by a simple elbow joint.

According to his arrangement the forearm is formed of a wooden block ending in a hook, and the tools must be tied on with a cord.

This construction, intended for agricultural laborers, has been recently improved by Dr. Peter, the writer of these lines, as seen in the illustration, and has come into practical use. The tools are not attached with a cord but are fastened into three small rings which are placed on the lower end of the forearm part. These rings are not far apart, and they can be made wide or narrow by screws in order to hold securely large or small handles. In this way the shape of the forearm piece may be very simple, and tools are clasped firmly.

The artificial hand which originated in the office of Dr. Hüsner in Barmen is also well worth mentioning. It was constructed for a lady bookkeeper, whose right hand, with the exception of the thumb, had been amputated. This hand is illustrated and described in the Journal of Orthopedic Surgery, edited by Prof. Hoffa.

We will now consider the construction of artificial legs and feet.

The contrivances for replacing the lower extremity were down to the 16th century not designed to conceal the loss of the limb, with the exception of the artificial foot of Elean the Hegesistratos. The appliance was only a solid staff as long as the lost leg, but was quite useful for walking.

The wooden leg is held in honor to this day, and will always remain the simplest and least expensive artificial limb.

The first attempt to replace it and to imitate a natural leg was made by "Le Petit Lorrain," the locksmith of Paris (whom we have already referred to) in the second half of the 16th century. The apparatus was designed for a man who had his thigh amputated, and consisted of a tin shell for the thigh stump and a tin boot, furnished with an ankle articulation, and joined to the thigh piece by a knee articulation. An iron rod extended from the thigh covering in the inside down to the boot, and imparted firmness to the whole structure. The knee joint could be flexed by means of a strap fastened at one end to the hip. This apparatus was rather heavy and cumbersome and attended with the objection that the end of the thigh stump had to carry the weight of the body, and the stump cicatrix had to endure a constant pressure. In the year 1696 the Dutch surgeon Verduin prepared a shell for the lower part of the limb, in which the amputation cicatrix was free from pressure. The apparatus was composed of a wooden foot, a copper shell supported by two steel splints which extended both outside and inside from the foot to the knee, accompanied with two other jointed steel strips. The latter held the thigh firmly. The stump was covered with a long sack of chamois, held in place by the strips covering the thigh. It was suspended perfectly free in the copper shell, the cicatrix being also protected with a soft cushion.

In the year 1755 an artificial foot was constructed in the workshop of Hugo Ravatau. This apparatus was intended for a dragoon whose right foot had been amputated above the ankle. The whole mechanism consisted of a boot which reached above the knee, where it could be fastened with leather straps; the boot was laced its entire length. In its interior a metal strip extended on each side from top to bottom, and at the end was attached to a hollow metal cylinder, which was intended to replace the missing ankle joint. The boot had a metal sole. Inside of the cylinder was a coiled spring, with convolutions like a snail shell, forming a contour of the foot. Thus an elasticity was imparted in walking. The empty spaces in the inside of the boot were filled with horse hair. The dragoon by means of this contrivance was able to serve many years in the army.

During the years that followed numerous artificial limbs were constructed by Gavin Wilson, a mechanic of Edinburgh; by Charles White, of Manchester; Addison, of London, and the royal dentist Ballif, of Berlin. The latter made an artificial leg for the soldiers who in the war for liberty were maimed and suffered a thigh amputation. The mechanism of this leg reproduced the motions of the natural leg in walking more accurately than any that had been prepared before.

The artificial leg invented by James Potts, of Chelsea, England, was regarded in England and America as second to none for several decades. It was constructed for the Marquis of Anglesea, who lost the lower part of one leg in the battle of Waterloo. The limbs manufactured later after this pattern are called "Anglesea" legs. They are arranged in sections made of linden wood. The upper section, the thigh shell, surrounds the thigh down to ten centimeters above the knee joint, and up to the beginning of the thigh, not quite as high in front as behind. This must not fit around the thigh stump tightly, for the stump is to be covered, first with a thick sock of chamois and an additional sock of fluffy hosiery. The shell of the lower leg ends at the bottom in a compact piece of wood which is furnished with inside and outside articulation, quite similar to a natural lower leg. The sections for the thigh and for the leg are jointed together by steel rods at the sides.

The foot is without toes, but has a tip and carries in the ankle a piece of wood cut in the shape of a segment of circle and fitting exactly between the inside and outside of the ankle. The tip of the foot is jointed to the middle by a peg in order to enable it to be lifted in walking. The mechanism for motion is constructed in the following way: 1. From the hole the peg fits in near the tip of the foot, an elastic strap proceeds through the lower leg section for lifting the tip and preventing its striking forcibly against an object. 2. From the side steel strips of the thigh shell a catgut cord covered with leather reaches down to the heel. The strings lie, during their downward course, behind the knee joint, and enter from the back into the lower leg shell, a little to one side, and are joined at the heel somewhat in the manner of the tendon of Achilles. The foot sole is covered with layers of flannel and soft leather so as to make the step as noiseless as possible.

When these catgut strings are given the proper tension before the limb is used they serve as a substitute for the muscular structure of the calf of the leg. With these strings properly stretched the sole of the artificial foot can be placed squarely on the ground and the toes slightly raised while walking. When a step is taken the knee is bent, the rear catgut strings running into the toes are relaxed, while the toes are lifted by the elastic pulley which runs from the opening near the toe end to the lower leg. In a natural walk the bending of the knee is followed by the straightening of it and by setting the foot on the ground. In the apparatus, when the knee is straightened and the foot planted squarely on the ground the rear catgut strings are tautened, the foot is drawn backward lightly, and the springy forward movement necessary for a natural walk is obtained. This is the chief advantage of the "Anglesea" leg above those previously used; the walk is more natural and less fatiguing than with other apparatus.

Mr. Leiter, a mechanic of Vienna, has lately constructed "Anglesea" legs of less weight by using hard rubber instead of wood at convenient points.

In fact, several modifications of the "Anglesea" leg were produced at a later date. The "automatic artist," William Selpho, of New York, has skillfully improved the knee joint and the lower leg end. He has constructed a knee joint in which the shell of the thigh flares into a convex steel-covered knee-end; this fits into a correspondingly concaved knee-end of the lower leg shell, which is covered with leather. A steel tube joins the two respective surfaces. This pierces the knee-end of the lower leg shell and hinges into a bolt fixed in the center of the thigh shell.

The ankle joint resembles the knee joint as to attachment and form in a general way with this exception: the two joint surfaces, in case of the ankle joint, do not meet in a snug fit; there is an open segmental cleft between the lower leg joint and the joint surface of the foot proper. Into this cleft is fitted an elastic rubber plate to allow for minor lateral movements in walking over rough surfaces. The toe-joint is a simple socket joint. Instead of the layers of soft flannel and leather for the sole of the foot rubber was presently used to give the walk a spring and elasticity. A further advance was made in the so-called anatomical leg of Dr. Douglas Bly, an American. The American Academy of Medicine in New York and various civil and military official organizations of North America expressed their full appreciation of the work done, and the apparatus received the first prize medal at the exhibition at Syracuse in 1858. Prominent in this apparatus was the effort to adjust the artificial foot to any unevenness of surface in walking. As stated above, William Selpho had placed a rubber wedge into the forward segmental space of the ankle joint. Douglas Bly constructed the joint by means of a glass or ivory ball fitting on the one hand into the foot end of the shell of the lower leg, and on the other hand sunk into a bed of vulcanized rubber at the back of the foot. (See illustration.) The juncture of foot and leg is accomplished without bolts or hinge. Four catgut strings, two at the sides, one at the front and one at the back, are drawn firmly through a block at the lower-leg end, within and behind which, each string passes separately through a perforated cylinder of vulcanized rubber, generally called a railroad spring. By means of a thread at the upper end of the strings, these can be tightened more or less at the head of each cylinder by a nut, producing a more or less firm or loose connection between foot and leg.

The knee is a simple hinge joint. A circular segment at the knee end of the lower leg moves between two such segments at the knee-end of the thigh section. A cross bolt fastens the joint.

The solution of the problem of a joint, so ingeniously handled by Bly and Selpho, also occupied the attention of the well-known surgeon, Prof. Esmarch. He made the ankle joint entirely of wood and utilized it as a direct continuation of the lower leg. To facilitate easy and noiseless motion, he uses talcum powder placed in a cavity at the back of the foot. There is a broad spiral spring inserted in the hollow part of the foot, which lies anterior to the ball; this spring has two projections at its rear end, acting against the transversal of a steel cross, inserted in the front of the ball. The purpose of this spring is to replace the foot when it has been displaced by any unusual roughness of the road.

As skillful and practical as the ball ankle joint is, it still leaves much to be desired as far as firmness and safety in walking are concerned. This fact led A. Marks, of New York, to manufacture feet of soft rubber, all in one piece. In order to attach the foot to the lower-leg portion firmly, the rear end of the foot contains a solid wood core. Steel bands run down from the lower-leg and are fastened to this core.

The Marks feet have proven excellent. They are extremely elastic, adapt themselves readily to roughness of surface in walking and permit a noiseless walk.

Geffers, of Berlin, constructed a foot-joint in the latter half of the 19th century, which requires neither springs, nor catgut strings, nor crossbolts. (See illustration.) From the lower end of the artificial leg, a steel prism, *a*, projects downward into a steel-lined cut in the foot corresponding to the prism. Connection between foot and lower leg-end is established by a steel rod before and behind the prism. The fastening of these rods is accomplished by riveting the eye at the lower end of each rod to a peg, while the upper end is supplied with rubber springs at the head of which the threaded end is adjusted according to requirements by a nut.

There is no allowance made for lateral give, since the leg can move only forward and backward on the prism—but durability and safety are assured.

William Erfurth, of Weissenfels, belongs to the ranks of celebrated inventors of artificial limbs in the latter half of the 19th century. In the collection of the Friedrich Wilhelm Institute of Surgery of Berlin there are two artificial limbs from his workshop. The one is constructed for cases of amputation at the thigh, the other for cases at the knee. The two mechanisms are similar. The former is fastened by braces of rubber that run across the shoulders and consists of a thigh case to receive the stump, a lower-leg shell and a foot. (See illustration.) The knee-joint is formed thus: The lower leg has a circular segment surface at the upper end which engages with the two flanges of a similar but opposite segmental curvature projecting from both sides of the joint surface of the thigh piece. Pivot and axis are furnished by a steel cross-bolt. Ankle and toe joints are simple hinges and are maintained in rigid position by a spring in the sole of the foot. The bend of the knee is attained by lifting the heel, while the toes bear the weight of the leg.

In the interior of the apparatus, a leather-covered catgut string, *a*, runs up to the upper edge of the knee, passes over a transmitter, *b*, and down on the opposite side to the heel. On either side of the catgut string, there are two auxiliary springs to regulate its elasticity and tension, both in the ascent and descent. These are of the following construction: On either side there is a wire spring in a leather case, *c*; the leather case is open at the top and closed at the bottom, with the exception of a central opening. Each wire spring is closed at the top by a transverse disk. In the one spring fastened on the transverse disk, a catgut string starts, runs through the axis of the spring and thence down to the forward surface of the foot-end of the lower leg, *d*. Thence it passes through an adjustable loop, *e*, and thence returns to the spring on the other side, passes through the axis of the spring on the other side and ends in its upper transverse disk. The whole auxiliary spring apparatus is attached to a belt, *f*, which runs from one spring to the other. This is fastened to the above mentioned catgut string, which passes from the heel over the knee joint and back again. The fastening is made a few centimeters below the knee-joint. The spiral spring is maintained in tension by the fact that the leather cover is closed top and bottom and only open at the center.

Finally, a powerful spring, *g*, is attached at the heel, at the point where the above-mentioned catgut string starts. This spring extends two-thirds of the distance up the lower-leg, where it presses against a diaphragm attached to the point, *h*. In general, the joints and parts are lined with felt and leather and supplied in various places with rubber buffers. In order to walk, nothing is required but to lift the stump. By this means the foot is relieved of the entire weight of the body. This releases the spring on the heel, *g*, which presses downward and lifts the toes. But as the heel is depressed, the large catgut string, *a*, is made tense

from above downward, which causes a bending of the knee. Thus at the same time both ankle and knee are bent, the center of gravity of the whole leg is moved upward and backward, and the leg begins to swing forward like a pendulum from its point of attachment, i. e., from the hip. According to the laws of physics, as soon as this swing has begun and the thigh has been moved forward sufficiently, the lower leg will swing still further forward and will be thrown into the tense position required for the completion of the step. The springs and catgut strings thus become subject again to the same tension required for the incipience of the next step. The whole apparatus weighs four kilogrammes. Erfurth, himself, lost his leg at the thigh and wore this artificial leg.

Dr. Herter, physician of the staff, writes in the German Militaeraerztliche Zeitschrift as follows concerning this admirable apparatus: "Erfurth himself can never be found in his workshop, where heavy smithing work is of frequent occurrence, without his artificial leg. On the street it can with difficulty be distinguished from the natural leg. A blacksmith of this town wears a similar leg while at his work. One of the employés of a brewery here is furnished with an Erfurth leg also. One day his astonished chief saw him at the top of a load of grain-bags actively engaged in unloading the team. An *invalide* of the campaign of 1866, carpenter by trade, who was recently treated at the hospital, stated that he had been able with an Erfurth leg to climb any scaffolding and to walk with certainty along a beam at a dizzy height. It is further stated that when Emperor Wilhelm I. passed the station of Weissenfels, on his return from France on the 17th of March, 1871, a number of men stood on the platform who were supplied with Erfurth legs.

A number of further constructions differ from those already described, very slightly or simply from the fact that they are designed for special cases of amputation.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Trade With the United States in 1901.—The United States holds first place in the import trade of Germany and stands third on the list of countries receiving her exports, being surpassed only by Great Britain and Austria-Hungary, in the order named. According to recently published reports, German foreign commerce during the year 1901 suffered but slight diminution in the volume of exports and imports, compared with the preceding year, the former decreasing 1 per cent and the latter 3½ per cent. In value, the imports dropped off 1½ per cent, while the exports slightly advanced. The importation of American goods into Germany increased about 8 per cent compared with the previous year. On the other hand, there was a decline of not less than 18 per cent in German exports to the United States.

An unusually large quantity of American wheat was shipped to Germany, amounting to almost 1,250,000 tons, which was nearly three times as much as had been shipped the year before and double the amount imported in 1899. There was also a rather heavy importation of rye, though it did not by any means reach the figures of former years. Other grain and food supplies showed a decided decrease in the tables of imports. Barley, for instance, dropped to less than one-fifth the amount of former years, while the importations of bran shrunk to less than one-third. The most striking falling off was in corn, or maize, which, next to cotton, is the leading article of export from the United States to Germany. On account of the poor crop in America, Germany's imports, which for years have amounted to more than 1,000,000 tons, were reduced fully one-third.

Of other agricultural products, cotton seed and especially linseed and rape seed were imported in larger quantities. The shipments of grass and clover seed, however, were considerably smaller, the latter being reduced to less than one-fifth. In spite of high prices, wheat flour more than held its own during the past year. The imports of cotton-seed oil, oleomargarine, and particularly oil cake, which have been growing considerably during the past few years, still further increased in 1901.

Compared with former years, there was less refined petroleum sold to this country, while crude mineral oils met with larger sales. Tallow and other refuse fats dropped considerably in the list of importations, but other animal products about held their own.

Of mineral products, the importation of copper, lead, iron, and other raw metals decreased enormously. Crude copper and crude iron shrank more than a third and dropped to the level of 1896, while the importations of lead were reduced to about two-thirds of their former volume. In machinery, there was a decided decrease, especially in agricultural implements, and sewing machines suffered a reduction of about 25 per cent compared with the sales of former years.

American lumber and oak staves also show a very remarkable falling off. On the other hand, the importation of box and mahogany woods was almost trebled, and there was a great deal more cedar brought into this country.

The importation of meats and bacon was a trifle larger than heretofore, while canned meat and sausages entirely disappeared from the list, owing to the recent enactment of prohibitive laws. Lard did not reach its former volume. Dried fruit dropped considerably, and a slight decrease was also noticeable in the importation of tobacco. However, the amount of cotton sold to Germany remained about the same as in preceding years, namely, some 1,700,000 bales.

As to the exports from Germany to America, the most striking feature is the great decrease in the shipments of raw beet sugar. This loss amounted to more than two-thirds of the exports of the preceding year. In fact, the shipments were less than those of any year since 1895. Next to sugar, cement suffered most, showing a decrease of about one-half from the quantity shipped last year, and reaching a level not touched since 1890. But there was a very large augmentation in the exports from Germany to the United States in the line of potash salts, of which ever-increasing quantities have been shipped from year to year. In 1901, they reached the highest mark, with a gain of 25 per cent.

In consequence of the unprecedented demand for crude iron and steel in the United States, which the home production, great as it was, could not satisfy, there were many American orders placed with German firms for pig iron and steel, wrought-iron rails, wire, and general hardware; but in machinery, exports to the United States decreased.

It is also worthy of note that there were numerous shipments of Irish potatoes to the United States, about five times as many as in the year before. This is also true of pease and lupines.

The shipments of drugs and chemicals increased, particularly cyanide, alizarin, and indigo. Aniline dyes did not do so well. Textile goods of cotton, wool, and half silk dropped considerably, especially cotton hosiery. Fine leather goods also suffered.

While blown glassware shows a decrease, the sales of porcelain were greater, especially of dinner sets, etc. In the manufacture of paper, there was less cellulose, as well as finished goods, sold to the United States. An increase is noted in the exportation of pelts and hides, especially of calf and goat skins. The export of polished rice, which had been depressed for years, showed a revival. Butter, wines, and toys of various kinds were fully as active as ever before.

To summarize, the increase in the shipments of wheat from the United States to Germany, valued at not less than $25,000,000, more than covers the loss in the shipments of corn, copper, iron, machinery, etc., but German exports show no such redeeming figures. The decline in sugar alone amounted to almost $10,000,000, to which is to be added a loss of about $5,000,000 worth of exports of textiles, leather goods, etc.

The foregoing data are summarized from an elaborate official report published in the Monatliche Nachrichten ueber den auswaertigen Handel des deutschen Zollgebietes, which is issued by the Imperial Statistical Bureau, Berlin.—Henry W. Diederich, Consul at Bremen.

Inquiry for American Agricultural Implements in Siam.—I have received the following letter from J. S. Sanitwongse, acting director-general of the Siam Canal, Land and Irrigation Company, which may prove of interest. In this connection, I would refer to my report on canals and irrigation in Siam, published in Advance Sheets No. 636 (Consular Reports No. 234):

"BANGKOK, January 25, 1902.

"SIR: You are already aware that the irrigation canals, which we have excavated and are still excavating, have opened up a large area of land for the cultivation of rice, which a short time ago was a wild grass jungle.

"Since the establishment of proper locks and sluices, this land has yielded excellent crops every year, and at the present time a large tract has been brought under cultivation. In many instances, the people have taken up more land than they can work by themselves, and for the necessary assistance have been compelled to resort to Laos labor. The demand for Laos labor is now greater than the supply, and wages are becoming exorbitant. As a result, the owners of the land will have to reduce the area under cultivation, or pay such prices for labor that only a very small margin of profit will be left. Besides, the Laos leave for their homes in the north in February, and if the crop is a large one, as it is this year, much of it is left on the ground.

"In addition to the above difficulties, there is another very serious one in regard to the buffalo, which is necessary for the cultivation of rice. Owing to the ravages of disease during the last two or three years, the price for these animals has gone up 100 per cent. With the enhanced prices of labor and buffaloes, the margin of profit to the owners is now very small. In view of these circumstances, I believe there will be a very good opening for some enterprising firm of your country to introduce machines to take the places of the Laos laborers and of the buffaloes. But before introducing any machines, it would be best to send out some competent person to study thoroughly the manner in which rice is cultivated here, the condition of the soil, water, etc. Such a person would then know exactly what machines will be able to do the work required.

"I have consulted with many landowners, and they have all agreed that they are willing to divide half their profits with anyone who will plow, reap, and thrash the rice for them. The owners, on their part, will do the sowing and raking, and will bring in the crop and do other necessary work.

"If it can be shown that rice can be cultivated successfully by machinery, there will be a demand for such machines, not only in this district, but in other rice areas of Siam, which will mean a considerable market for these manufacturers of your country.

"I trust that you will deem the above remarks worthy of consideration.

"Yours faithfully,

"J. S. SANITWONGSE, Acting Director-General."

In view of this letter and as showing something of the possibilities of the people of whom it speaks, the following may also prove of value:

CHARACTERISTICS OF THE LABORING MAN IN SIAM.

The indolence of the coolie as he is found in the city is a most discouraging element in any plan that looks toward his development, but a broader view reveals the fact that this characteristic is largely due to his environment; for, separated from the influences of the city and in his more natural sphere—the fields, the forests, and the streams—the average Siamese laborer is more industrious than the tropical climate would lead one to expect.

In general, the tenant farmer of Siam lives and dies a laborer, and makes no endeavor to become a landowner. Yet careful inquiries show that the number of tenants who have became proprietors varies with the incentive offered to improve their condition.

The percentage of natives who have acquired real property in different parts of Siam ranges all the way from zero to 10 per cent, while from the district about Klong Rangsit comes the encouraging record of over 50 per cent and from some sections, as high as 65 per cent. Here in this plain, where the jungle has been converted by irrigation into productive fields, inducements have been held out to the poor man, through a system of low prices, long time, and easy payments, to become the owner of his farm; and he has responded in a most encouraging manner. Overcoming the temptation of the gambling houses, and the trend toward dependence long accepted by his class, he has risen to this incentive in a surprising manner, and has, in ten years, converted the lair of the wild beast into a thrifty community of over 80,000 souls. And the continued demand made by him for better things is to-day far in excess of the supply.

Although the data is not of as general a nature as could be desired, so far as it is at hand, it would seem to argue much for the proposition that the poor laborer of Siam has within him that which will respond to a call to come up higher.—Hamilton King, Consul-General at Bangkok.

Meat Trade of Lourenco Marquez.—The meat trade of Lourenco Marquez may be divided into two classes—fresh meat and frozen meat. The fresh meat generally consists of trek oxen, Madagascar and Zanzibar cattle, Transvaal sheep and goat, and an occasional Delagoa Bay pig. The trek oxen are old, worn-out animals that have traveled many weary miles over the rough South African roads. When they have become unfit for draft purposes they are slaughtered. Madagascar and Zanzibar oxen are small and lean, and their flesh is as tough and tasteless as that of the trek oxen.

The local butchers send from one to half a dozen animals to the slaughterhouse every night. Early in the morning the animals are killed by being stabbed in the back of the neck, where the spinal column joins the skull; the hearts, livers, lungs, and a few other organs are inspected by a municipal physician detailed for that purpose. After inspection the carcasses are immediately cut up, and by 5 A. M. the various parts are hanging in the local butcher shops ready for sale. By noonday, the butchers are sold out, their shops are closed, and in less than twenty-four hours from the time the animal was slaughtered the entire carcass is consumed.

None of the local butchers use ice, as it is very expensive, costing from 5 to 6 cents a pound.

Mutton and pork are prepared very much in the same manner as beef.

In cutting up meat for sale, local butchers endeavor to include as much bone as possible, so that every pound of the dressed carcass may be sold. Sometimes, there is more bone than meat in an ordinary piece of sirloin.

The frozen meat comes from Australia, and is kept in a small cold-storage warehouse. The retail trade in frozen meat is conducted in a manner similar to that in fresh meat—that is, there is no waste bone or fat.

None of the butchers or meat sellers deliver meat.

The equipment of a Lourenco Marquez butcher shop would amaze an American butcher. Everything is crude and antiquated. There are no refrigerators, and marble slabs and plate-glass windows are comparatively unknown. Instead of clean paper, old newspapers are used for wrapping purposes. At present, the average price of fresh beef is 30 cents a pound, while pork and mutton are quoted at about 60 cents.

No dressed poultry is sold here; the housekeeper must buy live fowls and have them prepared at home.—W. Stanley Hollis, Consul at Lourenco Marquez.

American Calicoes in Brazil.—Consul-General Seeger, of Rio Janeiro, under date of February 18, 1902, says:

I believe that, in spite of the hard times prevailing here, there is a good market in Brazil for the cheaper kinds of American prints in fast colors. The trouble seems to be, however, that the manufacturers in America will make no concessions—as do the English and Germans—to the peculiar tastes of the masses who are likely to buy those goods. It would be very easy for our manufacturers to procure samples of the patterns most salable in this market from dealers here. I received a letter the other day from a New York firm, containing some samples, which I submitted to the most important dry-goods house in this city. As a result, the firm received an order for 50 boxes of calico, and I was told that the purchase would have been much larger, if the buyers had been accorded choice of patterns.

Demand for Band Steel in Germany.—Consul Langer writes from Solingen, February 25, 1902, that he has received a communication from Otto Fuehrer, Remscheid-Vieringhausen, Germany, importer of iron, steel, wire and tin, asking for the names of firms manufacturing band steel used in the manufacture of gongs and bells, the house being desirous of purchasing this article in the United States. Parties interested can communicate directly with the inquirer.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Curry Powder.—

1. Cayenne pepper	1 to 4	drachms
Ginger	4	drachms
Mace	4	drachms
Cloves	4	drachms
Mustard	1½	ounces
Turmeric	2	ounces
White pepper	3	ounces
Fœnugreek	4	drachms

Reduce all to a fine powder and mix thoroughly, passing through a sieve.

2. Coriander seeds	1	ounce
Cayenne	1	ounce
Cumin seeds	2	ounces
Mustard	3	ounces
Jamaica ginger	3	ounces
White pepper	6	ounces
Turmeric	16	ounces
3. Black pepper	½	ounce
Allspice	½	ounce
Mustard (scorched)	1	ounce
Ginger	1	ounce
Fœnugreek seeds	2	ounces
Cinnamon bark	2	ounces
Turmeric	4	ounces
Coriander seeds	4	ounces

Reduce all to a fine powder and mix thoroughly, passing through a sieve.

4. Cayenne pepper	10	drachms
Ginger	4	ounces
Pimento	4	ounces
Dill fruits	4	ounces
Mustard seed	8	ounces
Cumin seed	8	ounces
Black pepper	8	ounces
Fœnugreek	12	ounces
Turmeric	1½	pounds
Coriander	5	pounds
Table salt	1½	ounces
5. Mace	1	drachm
Allspice	1½	ounces
Cumin	½	pound
Turmeric	½	pound
Coriander seed	1	pound
Black pepper	1	pound

—The Pharmaceutical Era.

Powder for Cleaning Gloves.—

White bole	60.0
Orris root (powdered)	30.0
Powdered grain soap	7.5
Powdered borax	15.0
Ammonium chloride	2.5

Mix the above ingredients. Moisten the gloves with a damp cloth, rub on the powder and brush off after the drying.—Pharmaceutische Zeitung.

Piano Polish.—

Gum mastic	65 parts
Shellac	250 parts
Alcohol (95 per cent)	1,000 parts

For the finest work, the alcoholic solution of the gums should be shaken with about one-tenth of its volume of benzine, and the latter drawn off after the mixture has been allowed to stand for a few hours. This gives greater mobility.—Bulletin of Pharmacy.

Glimmbilder (Glow Pictures) can be easily produced by drawing the outlines of a picture, writing, etc., on a piece of white paper with a solution of 40 parts of saltpeter and 20 parts of gum arabic in 40 parts of warm water, using a writing pen for this purpose. All the lines must connect, however, and one of them must run to the edge of the paper, where it should be marked with a fine lead pencil line. When a burning match is held to this spot, the line immediately glows on, spreading over the whole design, and the formerly invisible design finally appears entirely singed. This little trick is by no means dangerous.—Papier Zeitung.

Laundry Gloss Dressing.—

I. Dissolve White wax 5.0
in Ether 20.5
and add Spirit 75.0
Shake before use.

II. Heat until melted, in a pot, 1 kilo of wax and 1 kilo of stearine as well as a few drops of an essential oil. To the hot liquid add with careful stirring 250 grammes of ammonia lye of 10 per cent, whereby a thick, soft mass results immediately. Upon further heating same turns thin again, whereupon it is diluted with 20 liters of boiling water, mixed with 100 kilos of starch and poured into molds.—Seifensieder Zeitung.

Membranous Croup.—

Dr. J. C. Haring recommends the following for membranous croup:

Oil lobelia	1 drachm
Oil stillingia	2 drachms
Oil cajeput	3 drachms
Alcohol	1 ounce

Mix. Directions: One drop on sugar every two or three hours; if the case is very bad, give a drop every hour for three or four hours. Afterward give every two hours. Rub a little on the windpipe two or three times a day.—Med. World.

Whooping Cough Remedy.—

Dr. R. J. Blackham states that the following formula was largely used by Dr. R. A. Flynn and other physicians:

1. Zinci sulphatis	4 grammes
Tincturæ belladonnæ	48 minims
Aquæ anisi ad	2 ounces

M. Sig.: Twenty drops every third hour for a child one year old, thirty for a child three years old, sixty for a child five years old, and so on. In most cases, he says, it acts like a charm.—Southern Clin.

2. Ether	6 drachms
Chloroform	3 drachms
Oil turpentine	1 drachm

Mix. Pour some of the mixture on a cloth and hold to mouth so that the mixture is inhaled, thereby giving relief.—Pract. Drug.

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